Portland General Electric
121 SW Salmon Street • Portland, OR 97204
portlandgeneral.com

May 1, 2024

Via Electronic Filing

Public Utility Commission of Oregon
Attention: Filing Center
PO Box 1088
Salem, OR 97308-1088

Re: Docket No. UM 2033, PGE Transportation Electrification Plan

Filing Center:

Portland General Electric (PGE or the Company) is pleased to submit its first annual Transportation Electrification (TE) Plan Report to the Public Utility Commission of Oregon (OPUC or Commission) in compliance with ORS 757.357 and OAR Chapter 860, Division 87.

The TE Plan Report addresses PGE's TE-related activities and expenditures for program year 2023 under the Company's current TE Plan, which the Commission accepted with Order No. 23-380 on October 20, 2023.

Please contact Steven Corson at 503-550-0857 if you have questions or require further information. Please direct all formal correspondence and requests to pge.opuc.filings@pgn.com.

Thank you,

/s/ Riley Peck
Riley Peck
Senior Manager, Regulatory Strategy and Engagement

ATTACHMENT

Cc: UM 2033 Service List
Eric Shierman
Sarah Hall

2023 Transportation Electrification Plan report

May 1, 2024

PORTLAND GENERAL ELECTRIC

2023 Transportation Electrification Plan report

Table of Contents

PGE

Tables

Annual Report

Introduction

Portland General Electric Company (PGE or the Company) is pleased to share its first annual Transportation Electrification Plan (TE Plan) Report as required by the Public Utility Commission of Oregon's (OPUC's or Commission's) revised Division 87 rules. This report covers activities described in the company's current TE Plan, which the Commission accepted in October 2023. The material below is generally organized to be consistent with the report content requirements outlined in OAR 860-087-0030[1].

[1] Oregon Secretary of State, Public Utility Commission, *Chapter 860*. https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=4089

Chapter 1 Executive Summary

This TE Annual Report satisfies OAR 860-087-0030 requirements for utility reporting on spending, funding, benefit-cost analysis, ratepayer impact, performance/tracking/benchmarking metrics, and impacts to innovation, competition, and customer choice from the Company's current TE plan.

PGE's delivery of TE Plan programs has resulted in a greater number of charging ports installed than forecasted for the first year of the TE Plan. The Company spent $17.3 million of DEQ Clean Fuels funding, Monthly Meter Charge (MMC) funding and rate payer dollars in 2023 to deliver 62% of the forecasted ports for the entire three-year TE Plan, resulting in a slightly improved cost-benefit ratio than expected for the overall plan. As of year-end 2023, there are 57,685 electric vehicles (EVs) registered in PGE's service area, with an estimated CO_2e reduction of more than 200,000 metric tons. The count of EVs is less than forecasted but the percentage of EVs sold is still increasing from prior years.

In terms of equity, 79% of 2023 expenditures and 46% of the 2023 charging ports installed through PGE programs benefited underserved communities, while long term engagement work undertaken as part of the TE Plan has helped us glean insights to further improve our program designs to meet underserved community needs going forward. [2]

Although more EV chargers than forecasted have been installed as a result of program activity, PGE's 2023 expenditures on TE programs ramped up more slowly than forecast after plan approval. This was due to multiple factors, including a pause in installations of Municipal Charging Collaboration pole chargers, at the request of OPUC Safety Staff, while we obtained a third-party design review. In addition, two programs generated less market interest than expected or were otherwise underutilized: As noted in a UM 2033 letter filing in March, 2024[3] PGE is redeploying EV Affordable Housing Grant funding to serve the same use-case through multi-family rebates in the Business EV Charging Rebates program. And, money initially allocated for statewide education, as part of PGE's 2022 HB 2165 Monthly Meter Charge budget, has been reallocated to support panel upgrades in Residential Smart Charging after Clean Fuels Program dollars were budgeted to serve the education function under the TE Plan. Finally, because Clean Fuels Program grants reserve a portion of the funds to be distributed once the awardee has met final milestones, the reserved money may not be expended in the year it is awarded. Reserved funds will be spent in the next eighteen months once the grant project is complete (i.e. electric buses can take 12 months to deliver once ordered).

Residential Smart Charging Pilot, Business EV Charging Rebates program and the Fleet Partner Program port deployment and spend are on-track or ahead of the 2023 TE Plan schedule. We expect Municipal Charging Collaboration pole charger installation to fully recover from 2023 delays by Q1 2025. The redeployed dollars for multi-family rebates through Business EV Charging

---

[2] The percentage of underserved expenditures is higher than the underserved port percentage because Clean Fuels program funds grants do not always include charging ports and the grants vary in scope, supporting charging infrastructure, vehicles, education opportunities, community outreach or vocational training to benefit underserved communities.

[3] PGE letter filing available online at https://edocs.puc.state.or.us/efdocs/HAD/um2033had327499023.pdf

rebates and the Residential Panel Upgrade rebates will be fully deployed to support their respective participants by Q4 2025.

The report that follows more fully describes PGE's TE-related activities and outcomes for the first year of the 2023-25 TE Plan, in compliance with the Division 87 rules. Third-party PGE program evaluations are included in Appendix A of the report, and PGE's 2023 Clean Fuels Program report to the Department of Environmental Quality is included in Appendix B.

Chapter 2 Overview of 2023-2025 TE Plan

2.1 PGE's Strategy

Our strategy to plan, serve, and manage TE load guides the activity outlined in the 2023 TE Plan.

- Plan: PGE has made investments to plan for TE load, expanding our ability to model and forecast TE Load, which informs how best to serve that load.
- Serve: PGE has constructed a portfolio of initiatives meant to serve emerging TE loads and meet the needs of underserved communities through both multi-family and municipal charging programs. The portfolio will inform our approach to serve TE load as we would any new load, our development of TE-specific rates and tariffs, and also TE load management (see below).
- Manage: PGE is investing in and exploring approaches to manage TE load, whether through telematics to the electric vehicle or via communications to the EV charger. Where possible, the TE activity funded through this Plan requires participating customers to partner with PGE to manage load. Our plan is to pair investments in our Integrated Operations Center and Advanced Distribution Automation System with our managed load programs to utilize TE load as a resource, within our larger Virtual Power Plant (VPP) strategy, thereby enhancing our capability to reliably serve at least cost.

2.2 Funding

- Through Order No. 23-380, entered October 20, 2023, the Commission approved $96.0 million of funding for the transportation electrification market through four sources of funding: the Clean Fuels Program ($45.3 million), the HB 2165 Monthly Meter Charge ($23.0 million), existing/approved customer investment ($17.8 million), and an additional incremental investment from customers ($9.9 million).

2.3 Program overview

The 2023-2025 TE Plan is the continuation of programs approved in prior commission filings. The 2023-2025 TE Plan also revised some programs to better align them with PGE's TE strategy. PGE designed its portfolio of TE programs to meet the needs of various use cases and customer segments. In addition, all TE programs are designed to provide learnings regarding how best to meet customer needs and build grid-ready infrastructure that supports TE load management programs. The below table provides an overview of the programs which together comprise the TE portfolio.

Table 1: 2023 - 2025 TE Portfolio Overview

Programs	Overview	Target audience and goals
Business & Multi-Family Make-Ready Solutions	Rebate and make-ready support for business, workplace, public and multi-family support PGE provides technical support, and also installs/owns make-ready infrastructure	Public charging at businesses and multi-family locations Charging cost parity with schedule 7 customers in the multi-family sector

Programs	Overview	Target audience and goals
	Leverage learnings from this pilot to identify new approaches to meet the needs of underserved and multi-family sectors Rebate to support customer charger ownership, with the final payment provided at year five if rate follows Schedule 50 pricing	100 Level 2 (L2) ports by end of year 2025
Business EV Charging Rebates	Rebate to support customer charger ownership, with higher rebate amount provided to multi-family sites PGE provides technical support to businesses exploring charger installations for fleet, workplace, and public charging use cases	Workplace, multi-family, fleet, semi-public and public charging locations ~500 L2 port rebates, 250 L2 installation rebates, and 20 DCFC ports
Clean Fuels Program	Portfolio of programs funded through DEQ's residential EV owner credits, managed by PGE Programs include grants and infrastructure (Drive Change Fund and Electric School Bus grants), education and outreach activities, and emerging technology PGE and stakeholders created this portfolio approach in 2021	Programs and grants must support residential customers, with a focus on underserved communities
EV Ready Affordable Housing Grants	Grant program to support additional code requirements in percentage of parking spaces required to be EV-ready for new affordable housing sites	Affordable housing developments started prior to 2023 code update 100 parking space grants
Fleet Partner Pilot	Pair fleet advisory services with turnkey design and construction of make-ready for L2 and DCFC 10-year usage commitment Provides insight and visibility into fleet charging plans and locations Research managed charging strategies for fleet customers beyond current time of day pricing	Larger fleet customers 533 L2 and 110 DCFC make-ready ports by end of year 2025 13.2 MW of load capacity by 2028
Heavy Duty Charging Pilot	Install heavy-duty charging paired with solar and battery deployment to learn grid management with all technologies combined Coordinated site development Co-siting of storage and local generation where feasible Distribution upgrade insights West Coast Clean Transit Corridor (WCCTC) coordination	Medium- to heavy-duty charging users Two sites of medium- to heavy-duty charging Where feasible, sites must have solar and battery installed to manage the charging load
Portfolio Support	Funding to support TE-related program activities at the portfolio level	All TE programs and customer classes

Programs	Overview	Target audience and goals
	Grant-writing partnerships to utilize federal and state grant dollars to minimize rate payer impact Funding to expand load forecasting capabilities, data options, and modeling 2022 funding for statewide campaign support	
Public Charging - Electric Ave	Public charging pilot supporting six Electric Avenue sites across PGE's service area Support equitable transition to electric vehicles through utilizing schedule 50 rate, which is comparable to residential home charging costs Explore on-peak price signals to manage public charging load and minimize grid impact	Underserved residential customers Improve uptime to 90%+ for six Electric Avenue charging locations
Public Charging - Municipal Charging Collaboration	Pole charging and curbside charging installations to support equitable charging transition for underserved communities Build upon the success of the pole charging demonstration to support equitable neighborhood charging Utilize schedule 50, which is comparable to residential home charging costs Underserved community partnership	Underserved residential customers 180 pole chargers + 160 make-ready curbside by end of year 2025
Residential Smart Charging Pilot	A charger or telematics rebate to support residential customers' transition to electric vehicles, whilst minimizing impact to the electric grid Create equitable path for installation of chargers if panel upgrades are required Extend pilot enrollment through 2025 to incorporate learnings from Smart Grid Testbed demonstrations into future program design	Residential single-family EV owners Scale enrollments from ~2,200 as of EOY 2022 to +7,000 by EOY 2025 2.6 MW managed charging by EOY 2025

Chapter 3 TE Plan Expenditures (2023)

This chapter covers 2023 TE plan expenditures. Sections 3.1 and 3.2 detail expenditures by program and funding source, respectively. Section 3.3 details key lessons learned through evaluations, engaging underserved communities, and gauging market interest in 2023.

Actual TE Plan expenditures for 2023 were $17.3 million and did not meet the forecasted budget for 2023 due to various program delays (detailed in Section 3.1, below). The reduced expenditure still resulted in the addition of more EV ports than forecasted due to the sizeable increase of enrollments in the Residential Smart Charging pilot. As of the close of the year, 2023 port installations tallied 62% of the 2023-2025 goal. PGE plans to make up the expenditure shortfall and meet program goals by the end of 2025.

3.1 TE Plan Expenditures by program (2023-2025)

Table 2, below, illustrates both successful deployment of TE plan programs in 2023, as well as challenges that have resulted in expenditures below the forecasted budget.

Table 2: TE Program 2023 Forecasts and Actuals

Programs	2023 forecasted budget	2023 actuals
Business & Multi-Family Make-Ready Solutions	$210,100	$4,367
Business EV Charging Rebates	$460,000	$621,844
Clean Fuels Program*	$11,758,817	$8,398,989
EV Ready Affordable Housing Grants	$1,000,000	$130
Fleet Partner Pilot	$5,258,760	$4,161,840
Heavy Duty Charging Pilot	$1,997,290	$605,853
Portfolio Support	$1,811,500	$683,604
Public Charging - Municipal Charging Collaboration and Electric Ave	$4,927,903	$981,946
Residential Smart Charging Pilot	$2,417,000	$1,845,405
Grand Total	$29,841,370	$17,303,978

*Clean Fuels actuals plus reserved dollars (for future grant payments when grant work completes) equates to current and future grant spend of $10,061,122.

The full list of key lessons learned are included in Table 4 and a summary of program activities, including reasons that some program expenditures are less than forecast, are listed below:

- **Business & Multi-family Make-Ready Solutions** did not begin until late in 2023. The original program was approved through the 2023 HB2165 filing in April 2023. During the TE Plan stakeholder engagement, it became clear there was stakeholder confusion on the rate to be charged at multi-family locations. To improve program design and support multi-family pricing, the program did not start in earnest until the TE Plan was accepted in October 2023. This pushed out program implementation and expenditures by six months and the program is expected to reach full deployment by Q4 2025.
- **Business EV Charging Rebates** supported the installation of 88 L2 ports and seven DCFC port installations in 2023. The level of interest was higher than forecasted, with installations

occurring sooner than anticipated. As a result, 2023 program spending was higher than forecasted. Unspent dollars from EV Affordable Housing Grants (see below) will support additional multi-family charger rebates beyond 2024.

- **Clean Fuels Program:** In 2023, PGE awarded $6,532,530 dollars and procured 120 vehicles through the electric school bus grant program and Drive Change Fund.[4] The program also supported 1,548 EV test drives through ride-and-drive-events. Note that program expenditures do not match the forecast because of the grant structure of the Clean Fuels program. As a grant program, payments for a portion of each grant awarded are reserved until the grant work is completed: PGE disburses an up-front payment for 75% of the grant award for recipients to begin their grant project, and reserves the remaining 25% until completion of the grant work. $8,398,989 reflects the Clean Fuels dollars spent in 2023 for clean fuels' programs along with 75% of the grant awards. There is an additional $1,662,133 reserved from $11,758,817 funds to support the remaining payout when the grant work completes 2024 onward.
- **EV Affordable Housing Grants:** In the HB 2165 2022 filing, PGE proposed a grant program in response to pending code changes which would increase the number of parking spaces at new affordable housing sites required to have EV-ready infrastructure installed. After the code changed in March 2023, the market interest did not materialize despite significant outreach to potential applicants. PGE consulted with OPUC Staff and stakeholders and will redistribute the MMC funds from this program to Business EV Charging Rebates (see above) to support underserved community charging port installations. This is detailed in a PGE letter filing in UM 2033, dated March 22, 2024.[5]
- **Fleet Partner** completed make-ready infrastructure at 13 sites in 2023, enabling 186 Level 2 charging ports and 22 DC fast charging ports. Through Fleet Partner, PGE built the infrastructure to support Oregon's first electric Class 8 Semi trucks, Oregon's largest electric school bus fleet, and Oregon's first high-powered wireless charging installation. Customer satisfaction scores remained high, totaling 100% in 2023, with many customers applying for additional sites. Less funding was needed for outreach and education because the program's Phase 1 funding was fully reserved in early 2023. Also, some of the fleet sites planned for completion in 2023 had design changes that pushed the full installation into 2024 spend, which caused a slight underspend.
- **Heavy Duty Charging Pilot** progressed in 2023, delivering site construction drawings and beginning permitting for the Battery Energy Storage System (BESS) installation at the Electric Island Heavy Duty Charging site. Permitting delays pushed project completion into 2024 which changed the timing of the spend from 2023 to 2024 for the battery installation. As of April 2024, permits have been issued, construction is near complete, and the BESS installation is underway. Deployment of on-site solar generation was pushed into 2025 due to delayed RFP responses for pricing options and other permitting delays. With pushing battery completion into 2024 and the solar into 2025, the spend in 2024 is still on forecast

[4] The EV count includes "other" types of electric vehicles supported by the DCF including, an electric street sweeper, forklifts, tractors and electric bikes.

[5] Docket No. UM 2033, PGE's 3/22/2024 Notice of Grant Fund Reallocation, available online at https://edocs.puc.state.or.us/efdocs/HAD/um2033had327499023.pdf

but the 2025 forecasted spend increases by around $200,000. The total cost of Heavy-Duty Charging pilot may come in under the three-year budget as operational costs for 2025 are lower than anticipated since there is not a second Heavy-Duty site on the near-term horizon. Despite continued challenges with hardware and software development of a new charging system, megawatt-scale charging is planned to be deployed at the site in late 2025.

- **Portfolio support** expended fewer dollars in 2023 than forecast due to a variety of reasons. First, PGE was able to collect charger data more efficiently than expected. Second, PGE moved the update of our EV forecasting model into 2024. Third, PGE received no grant writing support requests in 2023 and will therefore pursue additional avenues to support partners in applying on federal and state grants. Fourth, the statewide campaign was supported in 2022 via MMC dollars but not all the dollars were needed to maintain and improve the Oregoin' website since Clean Fuels dollars met the statewide campaign scope in 2023. Finally, since statewide education needs are now funded through Clean Fuels outreach and education, the remaining 2022 HB2165 filing dollars allocated to the statewide campaign will be redeployed to support residential electrical panel upgrades (see below) through 2025.
- **Public Charging:**
    - **Electric Avenue** costs were lower than expected as PGE delayed outreach and education promoting awareness and use of Electric Avenues until downtime issues could be remediated. "Emergency fix" costs were also higher than originally forecast. Despite this, Electric Avenue usage increased in 2023. PGE also identified charger replacements to improve uptime, which are scheduled to be installed in 2024. As faulty chargers are replaced, PGE will restart outreach and education to alert users of the changes and also notify the broader public of the availability of public chargers in their neighborhoods.
    - **Municipal Charging Collaboration** successfully opened three new pole charging stations to serve the Milwaukie community. However, the program experienced several delays leading to spending below forecast. Lead times were slower than expected (e.g., meter bases took four months to arrive instead of three weeks) and didn't arrive until July 2023. Municipal contract negotiations also took longer than expected (three months to get a signed contract compared to the estimated timeframe of one month). These installations were further delayed in the fall of 2023 due to an unexpected PUC safety staff request for both a third-party evaluation of the design along and to cease further installations until the recommendation was received. This further delayed installations by four months until the approved recommended design was discussed with PUC safety staff in January 2024.
    - **Curbside Charging** work is on-track and awaits a determination on the viability of the initially proposed third-party ownership. PGE issued an RFP to understand if third party charging companies are able to charge customers a rate in line with schedule 50. RFP responses have been received and are under review. If third party pricing significantly exceeds schedule 50, PGE will explore additional options.
- **Residential Smart Charging Pilot:** the 2023 goal was to enroll 3,880 customers in the pilot. PGE surpassed the goal by 17% with 4,529 enrolled as of year-end. To support enrollment,

PGE issued 147 residential customer electrical panel upgrade rebates in 2023, fewer than originally forecast. The remaining 2023 funds will be utilized in 2024 for panel upgrades. PGE plans to use unspent statewide education dollars from the 2022 monthly meter charge filing (see Portfolio Support, above) to support panel upgrade rebates through 2025, if needed. Trade ally network funds will be spent in 2024 to help stand up the PGE+ program, through which residential customers can connect with qualified electricians to install their EV charger/upgrade their panel.

3.2 TE Plan Expenditures by Funding Source (2023-2025)

TE Plan funding comes from several different sources: Customer rates (GRC/Base Rates), Monthly Meter Charge (MMC), Deferral dollars, and Clean Fuels dollars from the DEQ program.

Capital expenditures are the main source of underspending for the GRC/Base Rates since Fleet Partner, Portfolio Support and the Heavy-Duty Charging Pilot did not use as much capital in 2023 as had been forecasted. Fleet Partner's marketing spend was also lower than forecast since that program's funding was fully reserved as of the TE Plan, and a second phase of the Fleet Partner Pilot only approved in October 2023. Section 3.1, above, explains the underspend of MMC and the Clean Fuels funds.

Table 3: TE Plan Expenditures by Funding Source: 2023 Forecasts and Actuals

TE Plan Funding Sources	2023 forecast	2023 actuals
GRC/Base Rates	$7,410,200	$5,253,572
MMC	$8,026,294	$1,414,881
Deferral	$2,646,059	$2,236,537
Grants	–	–
Clean Fuels*	$11,758,817	$8,398,989
Grand Total	**$29,841,370**	**$17,303,978**

*Clean Fuels actuals plus reserved dollars (for future grant payments when grant work completes) equates to current and future grant spend of $10,061,122.

3.3 Key lessons learned

The following table identifies key lessons learned from the third-party evaluations and program operations.

Table 4: 2023 Key Lessons Learned and Future Improvements

Programs	2023 Key Lessons Learned	Future Improvements
Business & Multi-Family Make-Ready Solutions	Paused from its original 2023 HB2165 filing implementation schedule (April 2023) until TE Plan approval (October 2023) so that program could be designed to address concerns regarding multi-family pricing	None at this time

Programs	2023 Key Lessons Learned	Future Improvements
Business EV Charging Rebates	Larger number of port installations occurred in 2023 than forecast The larger per-port rebate amounts for make-ready installations and DCFC port rebates were more quickly reserved than the lower charger rebate amount There is still a significant need for technical assistance for site users unfamiliar with charging infrastructure Rebates have a higher percentage of ports in underserved communities (76% of ports) Evaluation interviews indicate that rebates have often supported businesses already anticipating building charging infrastructure rather than supporting new builds. This may change as program awareness grows and the market shifts beyond early adopters There was a significant difference between the numbers of businesses which reserved rebate funding prior to installation compared to those which ended up installing chargers prior to applying for a rebate	Evaluate the effectiveness of the reservation system to support underserved communities Review and improve application processing and tracking Based on low market interest in EV Affordable Housing grants, the MMC funding will transition from that budget to the Business EV charging budget to support additional charging ports
Clean Fuels Program	Hosting an annual awardee networking event in 2023 for Drive Change Fund provided knowledge sharing and educational opportunities on charging and EV's for past and future DCF participants Additional dollars available for outreach and education required dedicated support staff to move forward all of the desired activities Moved the Electric School Bus grant timeframe to better align with school budget planning processes	Host an annual awardee networking event in 2024 for Electric School Bus Fund past and future participants Shift approach to ride-and-drives to increase participation of underserved communities Conduct a micromobility study to understand the utility's role
EV Ready Affordable Housing Grants	Though PGE saw some initial market interest in 2022, no grant applications materialized after the 2023 code changes	Plan to transition budget to Business EV Rebates to support additional L2 multi-family charging ports, as per March 2024 letter filing in UM 2033

Programs	2023 Key Lessons Learned	Future Improvements
Fleet Partner Pilot	Technical assistance is helpful for those businesses which need support to identify the type(s) of charger(s) that meet their fleet use cases Given the sometimes extended time needed for easements and the contract review, started this work earlier in the process Ordered long-lead time materials earlier in the process (at time of design approval) to mitigate any delays Given that the program was fully-reserved by 2023, improve customer-facing employees' awareness of program funding availability and other rebate opportunities.	Automate annual Fleet Partner customer reports to ensure customers are aware of energy commitment and energy usage Review Total Cost of Ownership tool for improvements and efficiencies as the EV fleet market changes
Heavy Duty Charging Pilot	Where possible, make-ready infrastructure should be installed such that it is easy-to-access for future maintenance Additional design and installation guidance is needed for customers wishing to future proof their site to accommodate easier maintenance, future additions of chargers, optimal charger placement or equipment changes Battery permitting takes longer than anticipated and should be started early in the process Charging standards and design work take longer than anticipated when working on new types of charging and/or vehicles (i.e., MW chargers and vehicles)	Need a future evaluation of build timeframes when integrating solar and battery In the future, utilize contractors with extensive permitting experience to expedite the permitting process for battery or solar installations Provide more on-site guidance during installs
Portfolio Support	Quality charging data requires ongoing management given its complexity and varying vendor data maturity DMV data reflects the number of registered EV's but does not represent the number of EVs charging or driving in PGE service area	Utilize additional sources of data such as EPRI's EV2Scale information along with other telematics or disaggregation data to identify where vehicles are charged and located Determine best means by which to provide outside organizations with grant-writing support

Programs	2023 Key Lessons Learned	Future Improvements
	The grant opportunities which PGE found with partners already had outside grant writing support Statewide education improved website in 2022 and the TE Plan activities were fulfilled with Clean Fuels Outreach and Education funding in 2023	Redeploy MMC statewide funding to residential panel upgrades if funding is exhausted prior to 2025
Public Charging - Electric Avenue	Electric Avenue usage continues to increase apace with EV adoption Aging equipment requires more maintenance and issues require in-depth knowledge of charging infrastructure and network communications PGE's offering needs to support the additional functionality provided by newer chargers. Flat monthly subscription services are not broadly available in the market and new charging technology does not support it	Replace failing equipment with up-to-date/faster charging technology by the end of 2024 In UE 435, transition schedule 50 (public charging rate) to a per-kwh fee, including an idle fee, peak time adder, and an income-qualified discount Improve customer experience by including a customer feedback QR code for timely feedback along with peak pricing information on the wrap of the charger
Public Charging - Municipal Charging Collaboration	New pole chargers should result in even less vandalism and graffiti as chargers are mounted higher on the pole than demonstration chargers Cities and PUC safety staff need more education on charging equipment and process to feel comfortable with the pole charging PUC safety staff may require a third-party evaluation. For example, pole charger designs were reviewed by PUC safety staff in June 2023. In October, PGE received request to pause installations until a third-party evaluated the design and provided approval	Establish a clear communication plan with municipalities as well as a path for customer inquiries PGE and PUC safety staff determine at the beginning of the process whether a third-party evaluation is needed for the curbside charging standard Explore options to increase visibility of chargers Create additional marketing materials and revamp the program website to more effectively engage with customers
Residential Smart Charging Pilot	In response to continued requests for installer referrals, launched PGE+ in late 2023 which provides customers a seamless experience to connect with an electrician and install a qualified charger	Continue to simplify PGE+ installation, rebate, and enrollment processes Determine control group for telematics participants to best assess planning level for that group. 2024 kW goals will utilize updated planning value from draft evaluation

Programs	2023 Key Lessons Learned	Future Improvements
	About a third of panel upgrades supported income-qualified customers (as defined by HB2165), but less panel upgrades were required than forecasted Evaluation showed high customer satisfaction with the program, high retention rates, and low opt-out rates Telematics participants' usage was not easily comparable to the Electric Vehicle Service Equipment control group Evaluation returned lower per-participant kW impacts than the original planning value (curtailable load) during PGE's system peak period Pilot design misses one hour of current PGE system peak. Curtailable load is higher in the 10pm – 11:59pm period, due in part to the high proportion of Time of Day customers who charge overnight	model coincident peak demand time period More enrollments are planned which may require additional panel upgrade rebates. The panel upgrade rebates budget will be covered in 2025 with unspent MMC statewide educational dollars

Chapter 4 Evaluation

Third-party evaluations were conducted between April 2023 and October 2023 and can be found in Appendix A. These reports include additional detail on lessons learned as well as charging profiles for programs with adequate charger session data during the evaluation timeframe.

For programs such as Municipal Charging Collaboration pole installation, which lacked sufficient enrollment (and therefore customer data) to evaluate program effectiveness in this timeframe, evaluations were postponed until 2024.

Of note, the UM1811 evaluation report reflects the purpose of the pilot based on PGE's TE Strategy at pilot inception (2018). PGE's TE strategy has since been updated through the 2023 TE Plan to reflect market changes and clarification of the utility's role.

Chapter 5 Performance categories and key lessons learned

5.1 Overall EV adoption and environmental benefits

Oregon's EV market continued to expand in 2023, with EV sales as a percentage of new car sales increasing from 10% to 14% over the prior year.[6] While the percentage of electric vehicles sold continues to grow, the rate of growth did not meet forecasted projections. The forecasted projections were based on the potential impact and growth in EV sales from the Inflation Reduction Act as well as additional models of cars available but additional market factors impacted actuals meeting forecast. For the Medium-Duty Vehicle and Heavy-Duty Vehicle, PGE is exploring additional options to gather this data as not all vehicles located in PGE service area are registered through the DMV in PGE's area codes.

Table 5: 2023 Vehicle Segment Sales: PGE Forecast to Actuals

Vehicle Segment	2023 forecast	2023 actuals
Light Duty Vehicles (LDV - PHEV and BEV)[7]	70,994	57,629
Medium-Duty Vehicle (MDV)	662	7
Heavy-Duty Vehicle (HDV)	355	49
Grand Total	**72,011**	**57,685**

Table 6: 2023 Estimated GHG Emissions Reductions from EV's Utilized in PGE Service Area

Vehicle Type	Vehicles in PGE's Service Area	Estimated Annual Miles Driven	Metric Tons from EV's	Estimated Annual Reduction in CO_2e (metric tons)	Estimated Annual Reduction in NOx (metric tons)	Estimated Annual Reduction in PM2.5 (metric tons)
Light Duty (LDV)[8]	57,629	632,074,872	51,619	207,435	598	6
Medium Duty (MDV)	7	148,176	12	107	1	0
Heavy Duty (HDV)	49	3,074,799	251	4,858	38	2
Total	**57,685**	**635,297,847**	**51,883**	**212,400**	**637**	**7**

To estimate the forecasted GHG emissions reductions from EVs registered in PGE's service area, PGE started with the number of EVs in our service area at the end of 2023. For LDVs, PGE used the residential registration counts provided by DEQ through June of 2023. For MDVs and HDVs, PGE used PGE's analysis of DMV registration data used for our AdopDER forecast model. Our analysis

[6]Oregon Department of Transportation statistic, Rogoway (March 31, 2024), The Oregonian. Oregon electric vehicle sales rise again – when might they overtake gas-powered cars? - oregonlive.com,

[7] The 2023 actual count of LDV is derived from DMV car registration data received as of December 31, 2023. Oregon DEQ 2023 counts were not available in time to use for the annual report.

[8] See footnote 6

assumes that each EV displaced a comparable ICE vehicle and also that each EV drove the same number of miles that ICE vehicle would have driven—namely, the average number of residential miles driven per vehicle in Oregon (from Federal Highway Administration data) for LDVs; and the average number of MDV miles driven nationally (from National Transportation Energy Data Book data) for MDVs.[9]

PGE utilized estimated miles driven per vehicle type to calculate an estimated annual miles driven for LDV, MDV, and HDV vehicles. For CO2e, PGE utilized EPA data to arrive at MTCO2e per mile driven from gasoline for LDV and diesel for MDV and HDV. PGE then subtracted the MTCO2e of PGE's energy mix (0.29, as reported to DEQ for 2022) to arrive at the CO2e values reduced from EVs registered in PGE service territory in 2023. PGE also utilized EPA data to calculate the estimated annual reduction in NOx and PM-2.5. As EPA and DEQ data is not readily available for SO2, and SO2 does not historically represent a significant source of emissions from transportation, PGE did not calculate SO2 emissions reduced from EVs registered in PGE Service Territory in 2023.

5.2 Program Participation and adoption

5.2.1 NUMBER OF PROGRAM-ENABLED PORTS BY USE CASE

Type of Metric: Performance metric

In the TE Plan, Table 30 forecasted how many total charging ports would be installed through PGE programs from 2023-2025 and which charging ports would support the various use cases of residential, multi-family, workplace, corridor public, non-corridor public, light duty vehicle fleet, and medium heavy-duty fleet. To align with reporting needs of program-enabled ports, PGE includes here the cumulative number of ports supported by the programs included in the TE Plan. The below table corrects the number of 2023-2025 forecasted ports to reflect the cumulative number of ports instead of the incremental number of ports which was used in Table 30 in the TE Plan.

Due to the increased enrollments in the Residential Smart Charging Pilot, the percentages are heavily weighted to the residential use case. As Municipal Charging Collaboration pole charger installations resume in 2024, the amount of non-corridor public charging will significantly increase. There were low numbers of Business EV Charging rebates for workplace in 2023, though there are an increasing number of 2024 applications for workplace charging. This trend will be monitored to support the transition to electric vehicles for residential customers who can't install charging at their home.

[9] Estimated Annual Miles Driven based on 10,968 annual miles driven per LDV (2022 Federal Highway Administration Data); 21,168 annual miles driven per MDV (National Transportation Energy Data Book); 62,751 annual miles driven per HDV (U.S. Department of Energy).

Table 7: Three-Year Program Enabled Ports Use Case Forecast Compared to 2023 Progress

	2023 – 2025 forecasted		2023 progression		
Use Case	Total Ports	% of Total	2023 Total Ports	% of Total 2023 Ports	% of 2023-2025 forecast achieved in 2023
Residential	6,097	77%	4,529	92%	74%
Multi-Family	73	1%	48	1%	66%
Workplace	683	9%	23	<1%	3%
Corridor Public	64	1%	42	1%	66%
Non-Corridor Public	340	4%	39	1%	11%
LDV Fleet	415	5%	186	4%	45%
MHD Fleet	242	3%	41	1%	17%
Total	**7,916**	**100%**	**4,908**	**100%**	**62%**

5.2.2 PERCENT OF TOTAL PUBLIC PORTS BY USE CASE WITHIN UTILITY SERVICE TERRITORY WHICH ARE PROGRAM-ENABLED

Type of Metric: Baselining metric

Table 8: 2023 Public Ports in PGE Service Area and Program-Enabled Public Ports

	Public Ports – December 2023	
Port Type	Total Publicly-Available Ports[10]	Public Ports from PGE Programs
L2	1,050	230
DCFC	272	37
Total	**1,322**	**267**

5.2.3 NUMBER OF PARTICIPANTS IN UTILITY PROGRAMS, BROKEN DOWN BY PROGRAM AND UNDERSERVED COMMUNITY STATUS

Type of Metric: Baselining metric

Participant count for the programs are listed in the table below along with a brief title for what was counted as a participant. For the public charging programs, underserved community status of public charging users cannot be derived from charging session data, though the public charging sites are benefitting underserved communities.

[10] USDOE: Alternative Fuels Data Center. See: https://afdc.energy.gov/. Accessed Dec, 31, 2023

Table 9: 2023 Participation and Count of Participants Benefitting Underserved Communities

Program	2023 Participants	# of 2023 Underserved Community Participants
Business & Multi-Family Make-Ready Solutions	–	–
Business EV Charging Rebates	20 sites	15 sites
Clean Fuels Program	47 grant awardees	47 grant awardees
EV Ready Affordable Housing Grants	–	–
Fleet Partner Pilot*	20 sites	10 sites
Heavy Duty Charging Pilot	1 site	–
Public Charging - Electric Ave	3,637 unique users	N/A
Public Charging - Municipal Charging Collaboration	5 unique users	N/A
Residential Smart Charging Pilot	4,529 participants	1,977 participants

*Fleet Partner Pilot had 20 participants in 2023 but only 13 participant sites were completed with chargers installed in order to count toward benefitting underserved communities.

5.3 Underserved community inclusion and engagement

Type of Metric: Baselining metric

In 2023, PGE initiated a long-term (three year) Underserved Community Engagement Process to engage members of underserved communities in the development and build out of the PGE TE portfolio. PGE contracted with a minority-owned firm (Thuy Tu Consulting) to lead the work, which included recruitment for, and implementation of, both working and focus groups, with the following goals:

- To better understand the perceptions, attitudes, and needs of underserved communities in relation to transportation electrification
- Integrate learnings into the design, implementation, and improvement of TE programs
- To build and strengthen relationships between PGE and underserved communities.

The first year of engagement does not align with the calendar year as the outreach work started mid-2023 and continues through May 2024. Through the facilitator, PGE convened a community-centered working group of individuals from the underserved communities demographic as defined in the HB2165.[11] PGE also convened nine unique focus groups of individuals who identify with a specific racial or cultural group as defined in the HB2165. The consultant recommended this strategy for participants' comfort, the necessity of conducting some sessions in Spanish, and because affinity groups often have deeper, more robust discussions. This approach also allows facilitators to identify themes and requests for specific community groups which PGE can use to implement equitable community engagement according to their unique interests and needs. The first of the 13 planned working and focus group sessions took place in October 2023. To maximize

[11] See footnote 5

accessibility for participants across our service area, all sessions were/will be held over video conference through May 2024 (the first year of engagement).

Looking ahead, PGE will incorporate learnings from this process to both inform future engagement strategies and also inform and modify its TE program portfolio to better meet the needs of communities underserved by TE.

5.4 Equity of program offerings to meet underserved communities

The annual report metric developed and adopted by the Commission only looks at the number of ports benefitting underserved communities, but some of PGE's TE programs do not deliver ports (e.g., some of the Drive Change Fund grants, Electric School Bus grants, or the Outreach and Education Clean Fuels program).

PGE forecasted that 58% of the three-year TE Portfolio expenditures would benefit underserved communities. In 2023, 79% of the $17.8 million spent on TE programs benefitted undeserved communities. The higher percentage of spend directly reflects higher numbers of program ports installed in underserved communities through the Business EV Charging Rebates and Fleet Partner Pilot along with the grant recipients' benefits to underserved communities.

Table 10: 2023 Program Spend Benefitting Underserved Communities

Program Name	2023 Program Actuals	Spend Benefitting Underserved Communities	% Spend Benefitting Underserved Communities
Business & Multi-Family Make-Ready Solutions	$4,367	–	N/A
Business EV Charging Rebates	$621,844	$400,428	64%
Clean Fuels Program	$8,398,989	$8,398,989	100%
EV Ready Affordable Housing Grants	$130	–	N/A
Fleet Partner Pilot	$4,161,840	$2,736,032	66%
Heavy Duty Charging Pilot	$605,853	–	0%
Portfolio Support	$683,604	–	0%
Public Charging - Municipal Charging Collaboration and Electric Ave	$981,946	$981,946	100%
Residential Smart Charging Pilot	$1,845,405	$805,557	44%
Totals	**$17,303,978**	**$13,322,951**	**79%**

5.4.1 PERCENT OF PROGRAM-ENABLED PORTS BY USE CASE BENEFITTING UNDERSERVED COMMUNITIES

Type of Metric: Baselining metric

The second view of program equity considers the ports installed exclusive of some Clean Fuels program elements which do not entail port installations (e.g. some of the Drive Change Fund

grants, Electric School Bus grants, or the Outreach and Education Clean Fuels program). 46% of the ports supported by PGE programs benefit underserved communities. This is a conservative estimate based solely on location of sites in the programs meeting the HB2165 definition of underserved communities as defined in the TE Plan. Using only the site location within a census tract to denote underserved community excludes the Residential Smart Charging program income-qualified participants, who receive a larger incentive to cover their charger or panel upgrade. This means the percentage of underserved community participation in Residential Smart charging is being understated – the percentage calculation needs to be updated to include income-qualified participants even if they do not live in an underserved census block. The methodology will be further refined in 2024 so the next report can include updated percentages.

Table 11: 2023 Program Enabled Ports by Use Case Benefitting Underserved Communities

	2023 progression		
Use Case	Total 2023-2025 Ports	# of Ports for Underserved Communities	% of Ports for Underserved Communities
Residential	4,529	1,977	44%
Multi-Family	48	48	100%
Workplace	41	35	85%
Corridor Public	44	8	18%
Non-Corridor Public	35	25	71%
LDV Fleet	191	126	66%
MHD Fleet	41	37	90%
Total	**4,929**	**2,256**	**46%**

5.4.2 TYPES OF ELECTRIC TRANSPORTATION TECHNOLOGY SUPPORTED BY PERCENT OF TOTAL INVESTMENTS

Type of Metric: Baselining metric

Table 12: TE Portfolio Percent of Spend by Transportation Technology[12]

Passenger vehicles	LDV Fleet	MHDV Fleet	School Buses	Transit Buses	Micromobility
32%	29%	12%	21%	5%	2%

5.4.3 TRANSIT AGENCY ANNUAL SERVICE HOURS, NUMBER OF ROUTES, AND NUMBER OF ROUTES SERVING UNDERSERVED COMMUNITIES

Type of Metric: Tracking

TriMet participated in transit charging through UM1938 pilots, which support the installation of charging infrastructure for both overnight and enroute charging. TriMet also participated in the Fleet Partner pilot in 2023, but their sites will not be completed until 2024.

[12] Due to rounding, the sum of the percentages is over 100%

The electric buses which utilize chargers installed as part of the UM1938 pilot serve six different routes, all of which benefit underserved communities. See Appendix C for a map of the routes served.

Table 13: Transit Agency Program Participant 2023 Electric Vehicle Use

Transit Agency	PGE Program Participation	Annual Bus Service Hours	# of Routes	# of Routes Serving Underserved Communities
Tri-Met	UM1938 Tri-met chargers	18,573	6	6

5.5 Distribution system impacts and grid integration benefits

5.6.1 PERCENT OF PROGRAM-ENABLED CHARGING LOAD THAT OCCURS OFF-PEAK BY USE CASE

Type of Metric: Performance metric

Third-party evaluations include information on the amount of off-peak charging which occurred during the evaluation timeframe (see Appendix A). The evaluation timeframe includes data from program-enrolled chargers received prior to October 2023. The below table includes off-peak charging data received from commercial charging programs through December 2023. The residential data is confined to the evaluation timeframe. For the below table, the on-peak period reflects the system peak of 5-9 pm, as referenced in the TE Plan. The majority of MWh use for all use cases occurred off-peak, and therefore supported grid resiliency. Future managed charging programs should continue to find pathways to support additional off-peak charging as well as to create a smoother path into off-peak charging so that additional peaks are not created right after the off-peak period begins.

Table 14: Forecasted On-Peak and Off-Peak MWh Compared to 2023 Actuals

	2022 – 2025 Forecast		2023 Actuals	
Use Case	On-Peak MWh %	Off-Peak MWh %	On-Peak MWh %	Off-Peak MWh %
Residential	37%	63%	9%	91%
Multi-Family	56%	44%	25%	75%
Workplace	15%	85%	25%	75%
Corridor Public	21%	79%	17%	83%
Non-Corridor Public	100%	0%	20%	80%
LDV Fleet	43%	57%	16%	84%
MHD Fleet	37%	63%	24%	76%

The residential use case includes a managed charging pilot which contributed to the higher amount of off-peak MWh usage, whereas other use cases reflect time of use rates or rate options. The evaluation confirmed that the managed charging program is effective in shifting charging timeframes outside of the system peak time period. The non-residential use cases currently are only influenced by the current commercial time of use rate structure but have capacity to shift more

charging to off-peak through managed charging for some multi-family, workplace and some fleet use cases. Future commercial managed charging demonstrations will help evaluate the ability to both shift more charging outside of the system peak period and also smooth the usage curve after the off-peak period begins.

5.6.2 TOTAL EV LOAD ENROLLED IN MANAGED CHARGING, AND POTENTIAL FOR MANAGED CHARGING. ESTIMATED PERCENT OF EV LOAD ENROLLED IN MANAGED CHARGING

Type of Metric: Performance metric

As defined, managed charging includes direct load control, vehicle-to-grid, and behavioral demand response, but does not include time of use rates. At this time, vehicle-to-grid (V2G) chargers remain a nascent technology. PGE is conducting demonstrations to test the viability of the technology and associated processes. V2G potential will not be included in the potential for managed charging until PGE has completed the demonstrations in the Smart Grid Testbed and through the Emerging Technology V2G school bus demonstration.

The Residential Smart Charging pilot's increased enrollments equated to 2.0 MW of managed charging in 2023. As these programs are currently available only for residential customers, the potential MW for managed charging was calculated using the number of EV customers estimated to have access to home charging.

Table 15: 2023 MW Enrolled, and MW Forecasts Based on 2023 EV Count

MW's Enrolled in Managed Charging	Estimates based on 2023 EV counts	
2023 Actuals	Potential for Managed Charging (MW)	Est % EV Load Enrolled in Managed Charging
2.04 MW	14.0 MW	15%

In 2024, PGE updated the planning value for the Residential Smart Charging pilot. The planning value is used to demonstrate the amount of kW to be expected from an event. The updated planning value better reflects draft evaluation model results during the coincident peak demand time period (5-9 pm) rather than the kW saved over all the event hours for the two Residential Smart Charging event windows (5-8 pm and 10-12 pm). The updated planning value reflects seasonal impacts and results in 2024, starting with 1.04 MW (instead of 2.04 MW) enrolled. This new value will be used in the annual report for 2024 results.

5.6 Infrastructure performance

5.7.1 PRICE TO CHARGE AT PROGRAM-ENABLED PORTS BY USE CASE

Type of Metric: Baselining metric

The price to charge at commercial program-enabled ports is derived if the charger has pricing set by the owner (i.e., it's not free) and the charging software provider includes the cost to charge in their data sent to PGE. PGE derives the price by dividing the total cost to charge by the amount of kwh used for that session. PGE bases residential costs on Schedule 7's kwh costs since the pilot supports residential customers.

Multiple commercial customers utilize their program-enabled chargers for multiple use cases; this is especially true of recipients who utilize the Business EV Charging Rebates program. In this case, PGE includes the cost in each use case since the charging data does not include the purpose of the charging session to determine which use case benefitted from the session. Many employers seem to cover the cost of workplace charging for their employees. Non-corridor public charging includes PGE's pole charging installations as well Business EV Charging Rebates program customers who may have installed public charging along with other use cases. Business EV Charging Rebates program customers who had solely multi-family use case sites usually had per-kWh costs which ranged from free to $0.20/kWh but there were also a few outlier sites with costs higher than $0.20/kWh that require further investigation. There were four mixed-use case sites in Business EV Charging Rebate program installations in 2023 (mixed-use cases of multi-family, workplace, and public charging) which reflected costs of $0.20 - $0.35/kWh. Due to the lower number of mixed-use case sites, more site installations and customer interviews are needed to better understand the dynamics impacting multi-family site decisions on pricing.

Table 16: 2023 Price to Charge at Program Enabled Ports by Use Case

Use Case	Price per Port in 2023 ($/kWh)
Residential	0.16
Multi-Family	0.33
Workplace	0.08
Corridor Public	0.16
Non-Corridor Public	0.17
LDV Fleet	0.11
MHD Fleet	–

5.7.2 UPTIME AT UTILITY-OWNED AND SUPPORTED PORTS BY USE CASE

Type of Metric: Performance metric

PGE received uptime reporting from some vendors in 2023 and will work with vendors and program participants to obtain more uptime data in 2024 and 2025. Due to the limitations of the data available for the residential smart charging program, PGE currently lacks uptime data for those participants of the Residential Smart Charging pilot, but they would not qualify for a seasonal incentive if they did not have a connected chargers during the season.

The corridor public chargers line item reflects PGE's Electric Avenue chargers, which experienced increasing downtime issues in 2023 due to aging "first-generation" charging equipment deployed in 2019 and 2020. Since increased support in 2023 did not result in 90% uptime, the chargers will be replaced in 2024 to improve uptime and increase the charging speed to support new standards. The MHD fleet use case reflects thirteen chargers, one of which (a newer model at a school district) experienced issues. Given the relatively small sample size, this brought down the average uptime; were the problem charger excluded, MHD Fleet uptime would increase to 92%.

Table 17: 2023 Uptime for Program Enabled Chargers by Use Case

Use Case	2023 Uptime %
Residential	Not available
Multi-Family	98%
Workplace	96%
Corridor Public	87%
Non-Corridor Public	96%
LDV Fleet	97%
MHD Fleet	87%

Chapter 6 Benefit-Cost Analysis and Estimated Ratepayer Impact

The TE Plan reflects three Benefit-Cost Ratio (BCR) tests: Rate Impact Measure (RIM), Total Resource Cost (TRC), and Societal Cost Test (SCT). The ratios are calculated with the benefits divided by the cost to implement a program. The tests vary as to the benefits included in the numerator. An increase in any ratio reflects a program which is more cost effective or demonstrates more environmental or societal benefits than forecasted in the TE Plan.

Each benefit-cost ratio increased over the forecasts from the 2023 TE Plan. The driving factors were enrollments/installments which surpassed the 2023 forecast while some costs to implement came in lower than forecast.

Table 18: Benefit-Cost Ratios for 2023 Program Costs and Benefits

Program	RIM	TRC	SCT
Business EV Charging Rebates	0.67	3.05	3.79
Business & Multi-Family Make-Ready Solutions	0.21	0.36	0.45
Clean Fuels Program	0.95	7.38	7.38
EV Ready Affordable Housing Grants	-	-	-
Fleet Partner Pilot	0.87	2.14	2.57
Heavy Duty Charging Pilot	0.97	1.29	1.60
Public Charging - Municipal Charging Collaboration and Electric Ave	0.38	0.56	0.65
Portfolio Support	-	-	-
Residential Smart Charging Pilot	1.12	2.71	3.30
Total	**0.74**	**1.70**	**1.99**

BCRs increased slightly since the TE Plan was submitted in 2023, which reflects increased benefits relative program cost.

Table 19: Variance in Benefit-Cost Ratios from Forecasts in TE Plan

Program	RIM	TRC	SCT
Business EV Charging Rebates	0.10	(0.03)	(0.04)
Business & Multi-Family Make-Ready Solutions	0.04	0.07	0.08
Clean Fuels Program	(0.05)	(4.61)	(4.61)
EV Ready Affordable Housing Grants	-	-	-
Fleet Partner Pilot	(0.12)	(0.27)	(0.33)
Heavy Duty Charging Pilot	0.38	0.54	0.67
Public Charging - Municipal Charging Collaboration and Electric Ave	0.02	0.08	0.09
Portfolio Support	-	-	-
Residential Smart Charging Pilot	0.29	0.79	0.96
Total	**0.06**	**0.15**	**0.19**

The BCR increased in a number of programs due to faster enrollments in the programs than originally forecasted (Business EV Charging Rebates and Residential Smart Charging Pilot) or the overall costs to deliver the program were less than anticipated (Heavy-Duty Charging Pilot), and

more than offset a decrease in the Fleet Partner Pilot results due to fewer DCFC installations and more L2 installations than originally forecasted (which was forecasted to bring in higher amounts of load). The large increase in BCR for Heavy-Duty Charging Pilot was due to a reduction in the need for engineering support costs in 2025 onward. The increase in BCR for Residential Smart Charging Pilot resulted from a significant increase in forecasted ports and resulting energy usage. The increase in BCR for Business EV Charging Rebates was due to the reduction in incentive costs resulting from the lower forecast of port installations, as well as the faster installation of ports than originally forecast.

Table 20, below, provides another measure to evaluate 2023 rate base expenditures and their impact on customer schedules. Due to the timing changes for capital project deployment (ie. Heavy-Duty Charging Pilot pushing out the battery installation to 2024 and the solar installation to 2025), the overall ratepayer impact for the TE portfolio decreases since the capital expenditures timing has spread over additional years.

Table 20: Ratepayer Impact for 2023 Expenditures and Forecasted Expenditures

Category	Schedule	2023 Rate Impact	2024 Rate Impact	2025 Rate Impact
Residential	7	0.07%	0.18%	0.15%
Small Non-residential	32	0.06%	0.16%	0.15%
Large Non-residential Time of Day	38	0.09%	0.22%	0.20%
Large Non-residential Capacity Tier	83	0.01%	0.04%	0.02%
Large Non-residential Capacity Tier	85	0.01%	0.05%	0.02%
Large Non- residential Capacity Tier	89	0.01%	0.05%	0.03%
Large Non- residential Capacity Tier	90	0.01%	0.04%	0.01%
Total Impact, All Schedules		0.04%	0.13%	0.10%

Chapter 7 TE Plan impact on innovation, competition, and customer choice in Oregon

The 2023 implementation of TE Plan activities positively impacted innovation, competition, and customer choice related to transportation electrification in Oregon. PGE includes transportation electrification as a pillar of innovation and a key part of enabling the grid of the future. In addition to operating one of the largest residential EV charging programs in the nation, the Company also evaluated emerging technologies in this arena. These included ongoing or one-time demonstrations of V2X, vehicle telematics, a mobile EV charging battery, exchangeable and back up HDV mobile batteries. Additionally, PGE continues to collaborate with Daimler on M/HD innovations at Electric Island.

PGE programs support competition and customer choice through program design and administration. During the 2023-year PGE issued five requests for proposals (RFPs) related to TE programs with an additional four RFPs planned for early 2024. RFPs not only support efforts to keep program costs low, but also drive market competition amongst goods and service providers. PGE provides a list of qualified chargers from which customers can choose a make and model compatible with our TE offerings. Three charger options are qualified for Residential Smart Charging. Commercial programs offer a choice of over 74 hardware/software combinations for L2, and 109 hardware/software combinations for DCFC.

Appendix

Appendix A: Evaluations

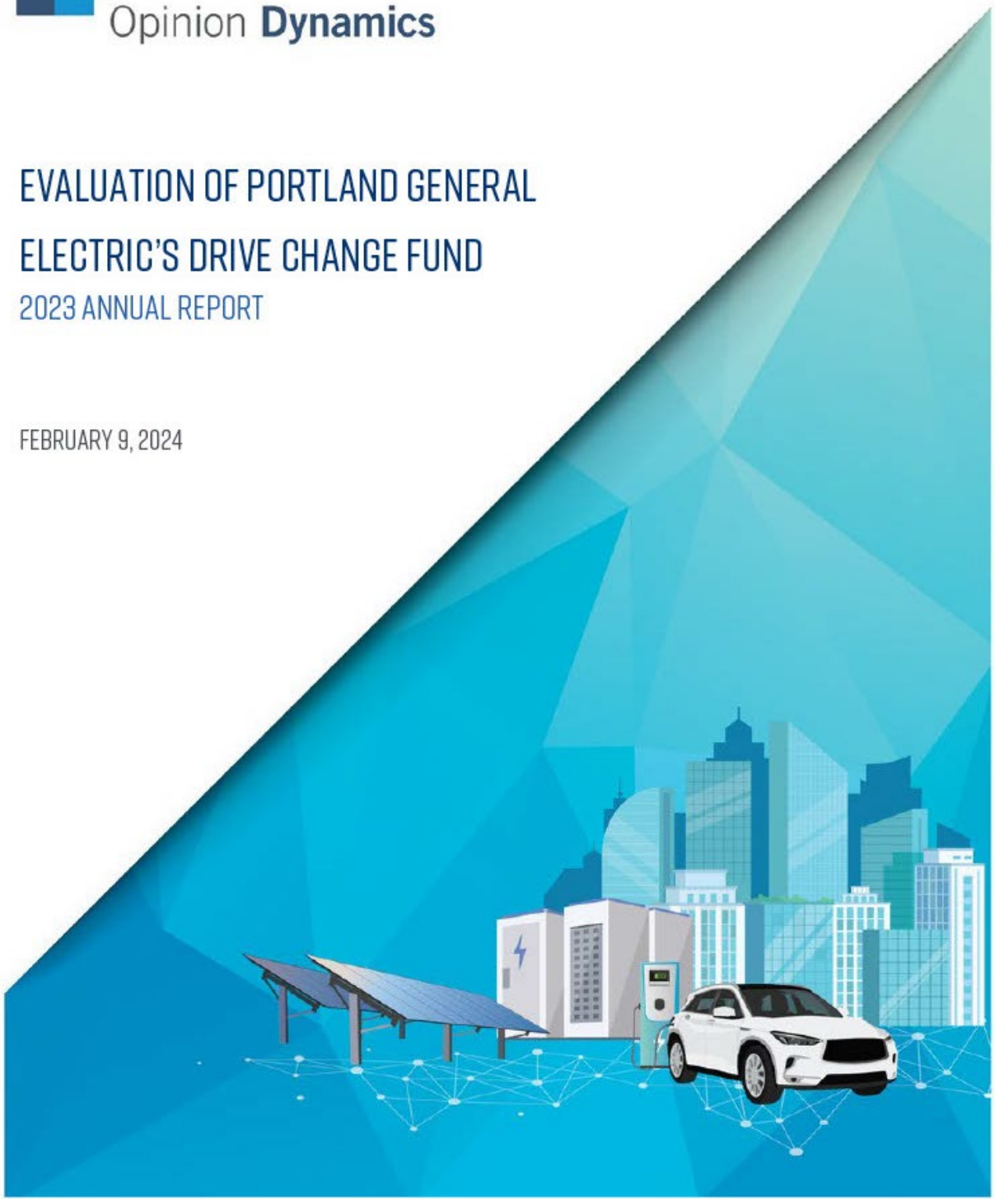
Appendix A.1: 2023 Drive Change Fund Evaluation

Opinion Dynamics

EVALUATION OF PORTLAND GENERAL ELECTRIC'S DRIVE CHANGE FUND

2023 ANNUAL REPORT

FEBRUARY 9, 2024



CONTENTS

TABLES & FIGURES

I. EXECUTIVE SUMMARY

I.1 DRIVE CHANGE FUND SUMMARY AND EVALUATION ACTIVITIES

Portland General Electric (PGE) launched the Drive Change Fund (DCF) in 2019, which is a grant-based program that provides funding to nonprofits, public agencies, and for-profit organizations to help underserved communities equitably benefit from new transportation electrification (TE) technologies. The DCF is funded by the Oregon Clean Fuels Program, with revenue generated from selling clean fuel credits. The funds support TE programs benefiting residential customers, with a focus on underserved communities. Stakeholder engagement, including engagement with partner organizations[1], is crucial in determining how the funds are utilized. The DCF offers funding for organizations to acquire electric vehicles (EVs) and EV charging equipment, as well as to conduct marketing, education, and outreach (ME&O) campaigns to educate underserved communities about the benefits of EVs.

In 2021, the fund provided $2.25 million to 10 grantees in the PGE service area.[2] Opinion Dynamics conducted an evaluation of the 2021 program year to assess the effectiveness of the program and identify areas of improvement. Our evaluation activities included interviews with program staff, grant reviewer staff, and participants in PGE's DCF from the 2021 program year.[3] The objectives of these interviews were to collect feedback from grantees regarding their participation experience, understand the avenues by which PGE is marketing and generating awareness about the DCF, and understand the program's impact on underserved communities. The PGE team and third party grant evaluator also conduct their own process improvement review annually. Some of the recommendations mentioned in this report have been implemented since the 2021 grant cycle.

I.2 KEY FINDINGS AND RECOMMENDATIONS

- **Expanding the DCF's Reach:** The DCF is reaching diverse organizations that serve various communities, including small and women/minority-owned businesses, low-income households, those experiencing homelessness, black, indigenous, people of color (BIPOC), and indigenous and migrant farmworkers. The majority of grantees are large nonprofits located in the Portland Metropolitan Area.
  - **Recommendation:** The DCF should continue to expand funding opportunities to more diverse nonprofits, including smaller nonprofits and more diverse priority communities, by conducting directed outreach through community-based organizations (CBOs) and previous grantees. The DCF should also continue to utilize previous grantees as messengers for the DCF.
- **Opportunities for Knowledge Sharing:** Program partners suggested that previous grantees provide testimonials about their experience in the DCF so new applicants and grantees can learn about their experiences, to avoid past mistakes and adopt successful application or project-implementation strategies that have worked in the past. All interviewed grantees said they would participate in such a knowledge-sharing network.
  - **Recommendation:** Utilize the network of previous grantees to provide testimonials to potential applicants. These testimonials could be a valuable resource for new applicants and existing grantees, offering insights into past experiences, lessons learned, and successful strategies. This collaborative platform could facilitate the dissemination of best practices, enable a proactive exchange of ideas, share lessons learned, and foster a

[1] Stakeholders and partners of the DCF include the Department of Environmental Quality (DEQ), Climate Solutions, the City of Portland Bureau of Planning and Sustainability, and NW Energy Coalition (NWEC).

[2] There were originally 11 grantees in the 2021 cycle; however, one organization returned the funds they received and withdrew from the program, which released $289,560 in funding back to the DCF.

[3] Due to the DCF funding cycle, this evaluation focuses on projects that were funded in 2021, however, organizations have since received funding in 2022 and 2023. The team plans to interview 2022 grantees in 2024 and conduct a charging utilization analysis, using charging data from participants whose projects included a charging component.

community of past grantees.[4] This knowledge-sharing initiative also aligns with the collective goal of leveraging successful DCF projects to enhance the impact and effectiveness of PGE's broader TE initiatives.

- **Challenges with the Application Process:** Grantees who had previously applied to the DCF had an easier time with the application since they had gone through the application process before. While all grantees were generally satisfied with the application process, there were some reservations about its length and technical complexity, which sometimes required third-party party expertise to complete.
  - **Recommendation 1:** The DCF could implement a voluntary intermediate application review step that provides feedback to applicants before they formally submit. This review would allow applicants to improve their application and increase the likelihood of submitting a successful application the first time instead of having to reapply. This step may make the application process more efficient and provide technical support to applicants without access to a third-party consultant.
  - **Recommendation 2:** Provide applicants with detailed technical information regarding proposed project elements, such as charging requirements or information about EVs early in the application process. Technical assistance provided at this stage could help applicants more fully understand the technical components required in the application and support their project planning process more effectively.
- **Opportunities for Cross-Participation with Other TE Programs:** Program partners believe there is potential to scale successful DCF projects, possibly through supplementary funding opportunities.
  - **Recommendation:** Provide more opportunities for current and previous grantees to engage with other funding opportunities. When opportunities arise, connect grantees with other TE-focused funding opportunities such as federal, state, or other local funding sources to expand grantees' TE efforts and broaden impacts on underserved communities. PGE could consider sending out quarterly or bi-annual newsletters that inform past and potential grantees of additional funding opportunities.
- **Formalizing Technical Assistance:** Most grantees were unaware that technical assistance was available or did not seek technical assistance from PGE. More commonly, applicants and grantees with charging and/or EV project components utilized a third-party organization for technical assistance.. At the same time, the DCF team helped ease technical difficulties by extending project deadlines and providing additional funding.
  - **Recommendation:** Consider implementing a standardized approach to technical assistance by formally integrating it into the DCF program. Integrating technical assistance into the process ensures that grantees are aware of and can access support directly through the DCF whenever needed. Alternatively, consider forming partnerships with third-party organizations and actively encourage grantees to collaborate with them. To streamline this process, consider:
    - Developing a trusted list of consultants endorsed by the DCF;
    - Encouraging applicants to engage these third-party organizations to navigate technical challenges; and
    - Enhancing internal technical assistance within PGE by establishing a dedicated DCF team that provides comprehensive technical support to applicants and grantees throughout the entire application or project lifecycle. This could include offering a standardized list of services for applicants with limited knowledge of TE technology covering technical aspects of charging and electric vehicle projects in addition to existing guides provided by PGE.

    By adopting these measures, PGE would fortify the technical assistance framework, ensuring a more robust and accessible support system for all stakeholders.

[4] Depending on PGE's administrative resources and capabilities, possible considerations could include: a monitored virtual community board for idea sharing, virtual networking meetings (occasionally in-person), and/or a pairing system that connects current and past applicant or grantee organizations with similar goals or projects.

- **Expanding Grantee Technical Assistance:** Grantees with EV charging elements often struggled with the application's technical components and the chargers installations.
  - **Recommendation:** Provide additional technical assistance for grantees with charging projects, including assistance identifying where to install the charger(s) and additional education about how to utilize the charger(s). One grantee mentioned that it would be helpful if the DCF could conduct site visits to identify the best installation location and help navigate any technical issues that may arise with the chosen location.
- **Documenting Impact on Communities:** DCF grants enable grantees to expand their impact on the communities they serve. Grantees appreciated how the DCF enabled their organization to learn about and experience TE technology, which has enabled them to better serve their priority communities with the additional funds provided by the DCF grant. Grantees also appreciated being able to serve their communities better without contributing to greenhouse gas emissions.
  - **Recommendation:** Consider obtaining impact statements from both grantees and community members served by the organization, which will help document and communicate the DCF's impact effectively. This qualitative approach provides a holistic understanding of the program's influence on priority communities.

2. INTRODUCTION

Portland General Electric (PGE) launched the Drive Change Fund (DCF) in 2019, which is a grant-based program that provides funding to nonprofits, public agencies, and for-profit organizations to help underserved communities equitably benefit from new transportation electrification (TE) technologies. The DCF is funded by the Department of Environmental Quality's Oregon Clean Fuels Program, with revenue generated from selling clean fuel credits. The funds support TE programs benefiting residential customers, with a focus on underserved communities. Stakeholder engagement, including engagement with partner organizations, is crucial in determining how the funds are utilized. The DCF offers funding for organizations to acquire electric vehicles (EVs) and EV charging equipment, as well as to conduct marketing, education, and outreach (ME&O) campaigns to educate underserved communities about the benefits of EVs.

The DCF continuously revises the application evaluation criteria to ensure projects are high-quality and equitably deployed. The DCF seeks to support not only EVs but also alternative forms of transportation, including e-bikes and micro-mobility; additionally, equitable deployment of electric transportation projects in underserved communities was a key consideration when developing applicant evaluation criteria.

The DCF has actively made changes to its program implementation team since 2021. The DCF has added a position focused on grant awardee experience and assistance from selection to completion. Program staff reported that adding this role helps ensure the timely completion of grantee projects and the distribution of funds. Before 2021, the DCF experienced delays in fund distribution and grantee project completion, which led to the addition of this role.

2.1 EVALUATION OBJECTIVES AND ACTIVITIES

For the 2023 evaluation, the team interviewed program staff, partner organizations, third-party grant reviewers, and grantees from the 2021 award year. This evaluation also covers the application and awards process for projects funded in 2021 and 2022. We conducted one round of staff interviews in the second quarter of 2023 that covered the 2021 and 2022 selection processes. Due to the timing of DCF project completion, we will conduct another round of interviews with grantees in 2024, covering 2022 projects after completion. We did not conduct charger pattern analysis as part of the 2023 evaluation due to the lack of charging data from 2021 grantees. We plan to conduct a charger pattern analysis of 2021 and 2022 grantees as part of the 2024 evaluation (Table 1).

Table 1. Summary of Evaluation Activities and Reporting

Evaluation Activities	2023 Annual Report	2024 Annual Report
PGE Staff Interviews and Program Enrollment Data Review	✓	✓
Partner Organization Interviews	✓	✓
2021 Grantee Interviews	✓	
2022 Grantee Interviews		✓
2021 Grantee Charging Pattern Analysis		✓
2022 Grantee Charging Pattern Analysis		✓

Table 2 summarizes interviews conducted as part of the 2023 evaluation. The team completed 12 in-depth interviews between May and September 2023.

Table 2. Disposition Summary for 2023 DCF Evaluation Interviews

	Contacted	Completed
DCF Staff	3	3
Partner Organizations	4	3
Third-Party Application Reviewer	1	1
2021 Grantees	10	5
Total	18	12

DCF STAFF INTERVIEWS

The team interviewed DCF staff involved with the implementation of grantee awards and management of the grantee experience. These interviews aimed to familiarize us with the DCF management structure and involved stakeholders and help us better understand program goals, challenges, and priorities. The interviews also supported the development of data collection instruments and data requests. The key objectives of the program staff interviews were to understand:

- Historical information about the DCF;
- Activities conducted to promote the DCF;
- The application review and selection process;
- The types of technical support provided to applicants and grantees; and
- The typical number of applicants and quality of the applications, the types of applicants and projects funded, lessons learned, and changes made to the process.

PROGRAM PARTNER INTERVIEWS

The team conducted in-depth interviews with three partner organizations involved in the early decision-making and operations of the DCF. These organizations included the Northwest Energy Coalition (NWC), the Oregon Clean Fuels Program (OCFP), and the Portland Clean Energy Fund (PCEF). All three organizations helped create the DCF, and their input formed the broad schema of what the DCF looks like today. The key objectives of the partner organizations interviews were to understand:

- The partner organization's role with the DCF, and to gather information regarding the program application process in 2021;
- The barriers that organizations face in applying to the DCF;
- How the DCF can more effectively provide resources to potential and current applicants; and
- The impact of the DCF on underserved communities and the goals of program partners for future iterations of the DCF.

GRANT APPLICATION REVIEWER INTERVIEW

The team interviewed Spark Northwest, the third-party grant application reviewer that PGE subcontracted to review grant applications to the DCF from 2020 to 2022. PGE now uses Resource Innovations as the third-party reviewer for grantee applications. Applications are scored according to the following criteria: project design and benefits, feasibility of timeline, and costs and financing. The third-party reviewer evaluates criteria holistically and considers each

organization's history and previous contributions to underserved communities. The key objectives of the application reviewer interviews were to understand:

- The application reviewer's role within the DCF, and to gather information regarding the program application process in 2021;
- The application and selection processes, including criteria for application selection, recourse for erroneous applications, and monitoring of accepted applicants (within the application process); and
- The types of application assistance and funding assistance that the DCF provides.

GRANTEE INTERVIEWS

The team interviewed five of the ten 2021 grantees in August and September of 2023. At the time of the interviews, none of the 2021 grantees had reached project completion due to various delays caused by internal and external factors (At the end of Q4 2023, six of the ten 2021 projects had been completed as shown in Table 4). We still completed interviews with these grantees to understand their application process and project execution experiences, and reasons for delays in project completion. The key objectives of the grantee interviews were to understand:

- Grantee satisfaction with the support that applicants received to complete the DCF application;
- The challenges applicants faced in filling out the application;
- The effectiveness of the assistance provided by the DCF, electric vehicle supply equipment vendors, and other involved contractor parties;
- Challenges grantees have faced procuring, installing, and maintaining their chargers or EVs; and
- The impact of organizations funded by the DCF on underserved communities.

3. DRIVE CHANGE FUND FINDINGS

This section presents detailed findings from our data tracking review and interviews with DCF staff, partner organizations, third-party application reviewers, and 2021 grantees.

3.1 GRANTEE CHARACTERISTICS

Grantees could receive funding for four types of projects:

- EV acquisition to support their operations;
- Installing charging infrastructure;
- Education and awareness campaigns to educate underserved communities about the benefits of TE technology; and/or
- Other innovative projects.

The DCF received 23 applications and funded ten grantees in 2021 (Table 3). Most 2021 grantees received funding for EV procurement, followed by ME&O campaigns and charging infrastructure projects. In 2021, the DCF funded the procurement of 16 EVs, three other vehicle types (e-bikes, e-tractors, ADA-accessible carts), and 25 charging ports. Of the five interviewed grantees, two completed projects involved all three components (EV procurement, ME&O, and charging), one implemented a charging and EV procurement project, one implemented an EV procurement project, and one conducted a TE educational campaign.

Table 3. Types of Projects Proposed and Awarded to 2021 Grantees

Type of Project	2021 Applicants (Proposed Projects)	2021 Grantees (Awarded Projects)	Interviewed 2021 Grantees (Awarded Projects)
EV Procurement	16	9	4
ME&O	13	7	3
Charging Infrastructure	20	6	3
Total Projects	23[a]	10[a]	5[a]

[a] Applications and projects may include multiple elements/components (i.e. EV procurement, ME&O, charging infrastructure)

All 2021 grantees are nonprofit organizations or public entities serving one or more underserved communities, primarily in the urban Portland Metropolitan Area. The grantee organizations that were funded in 2021 had various missions that support low-income populations, economic empowerment of priority communities, seniors and people with disabilities, community-based organizing, tribal communities, unhoused and veteran populations, and farm workers as shown in Table 4. Most interviewees reported having an operating budget of more than $2 million. Only one interviewed grantee reported having an operating budget of less than $2 million.[5]

[5] The Evaluation team reached out to grantees up to 5 times by email and phone in addition to outreach conducted by PGE on the evaluation team's behalf. Program staff noted that some grantees who did not respond to interview requests may have smaller operating budgets and may have had less time or resources available to respond to an interview request.

Table 4. 2021 DCF Grantee Organization Characteristics

Project Name	Grant Amount	Project Type	Populations Served	Project Status[6]
Camp Fire Columbia	$232,781	Chargers, EV, ME&O	Community youth	Ongoing
Clackamas County Social Services	$212,500	EV	Seniors and people with disabilities	Ongoing
Metropolitan Family Service	$136,278	ME&O	Low-income populations	Completed
Mt. Hood Community College	$300,000	Chargers, EV, ME&O	Local and regional workforce	Completed
Oregon Environmental Council	$240,881	Chargers, EV, ME&O	BIPOC- and female-owned businesses	Completed
PDX Diaper Bank	$59,970	EV	Underserved / Low-income families	Completed
Portland Community Reinvestment Initiatives	$64,963	Chargers, EV, ME&O	Low-income, with a focus on African-American populations	Completed
Sustainable Northwest	$277,966	EV, ME&O	Farms, low-income tribal communities	Ongoing
Transition Projects	$309,721	Chargers, EV	Unhoused and veteran populations	Ongoing
Willamette Valley Law Project	$131,941	Chargers, EV, ME&O	Farm workers	Completed

3.2 MARKETING AND AWARENESS

The DCF aims to reach a diverse range of applicants, including smaller organizations and culturally specific entities. To accomplish this, program staff proactively market the DCF to potential applicants through social media channels, email outreach, word-of-mouth, and storytelling through news articles and press releases. Program staff also actively engage with organizations throughout the year and make themselves available for one-on-one conversations with potential applicants to encourage qualified candidates to apply. Technical assistance from PGE engineers is also available to educate potential applicants about the DCF's specific TE requirements. Finally, DCF staff host applicant webinars. These webinars are open to all potential applicant organizations and cover application requirements, the application process, and awardee experience.

In line with program outreach efforts, interviewed grantees learned about the DCF through a previous grantee or PGE directly. Three out of five grantees reported hearing about the DCF through a previous grantee or a third-party organization. The two remaining grantees had previously worked with PGE and learned of the DCF through that experience.

Partner organizations agreed that the DCF has successfully reached community-based and nonprofit organizations that promote or implement TE projects in underserved communities; however, they would like to see more education and outreach to encourage the adoption of TE technologies. All partner organizations emphasized the importance of prioritizing underserved communities during the initial planning stages of the DCF. One partner noted that the applicant support processes are structured to provide equal opportunities for CBOs and nonprofit organizations, which usually operate with limited resources, staffing, and budgets. This is particularly helpful for organizations that may not have a dedicated grant writer on staff. All program partners highlighted the potential for the DCF to expand in future years. Two partners noted that the new influx of federal funding for energy projects – through the Inflation Reduction Act (IRA)[7] -

[6] As of Q4 of 2023, 60% of the 2021 DCF projects had been completed, and the remaining grantees reported that they were preparing to complete their projects.

[7] The DCF is not eligible to receive IRA funding directly, however applicants to the DCF and grantees could apply independently.

could help the DCF to enhance its impacts if it were to relay information about these additional funding opportunities to grantees.

Additionally, program partners noted that one of the main barriers to TE adoption in underserved communities is a lack of knowledge of how TE can benefit them. One partner believes that TE is now firmly established in public policy, although convincing customers to adopt EVs is still challenging for utilities, policymakers, and CBOs.

> *"Every single conversation that I hop into, there's so much fear, so much misinformation, so much confusion about what it is and what it's not, you know? On the regulatory/policy side, we know what the future is, but trying to get you to buy your next car to make it electric is a huge undertaking."*

Another program partner mentioned that some priority communities are concerned how investments in EV infrastructure could contribute to gentrification. Program partners want to ensure that community investments are thoughtful and do not lead to harmful, unintended consequences for priority communities. Two program partners recommended utilizing trusted community members to communicate the benefits of TE to priority communities and assuage concerns about the potential ramifications of additional TE investment. By fostering collaborative relationships with these key stakeholders, the DCF can work with grantees to ensure that investments are aligned with the unique needs and aspirations of each community.

3.3 APPLICATION PROCESS

In 2021, the DCF grant application process involved applicants accessing and downloading a PDF form from the website, filling it out, and submitting it with necessary attachments to PGE via email.[8] The PGE DCF grants manager reviewed applications for eligibility, completeness, and program fit. Subsequently, they were forwarded to the third-party application reviewer for evaluation based on a rubric covering project design and benefits, feasibility of timeline, and costs and financing. Interviews were then conducted by the third-party reviewer with organizations that met the initial qualifications of the DCF. The third-party reviewer synthesized these data into one-page summaries for each applicant, which were sent to PGE for review by a selection committee comprising various PGE team representatives and stakeholders. The third-party reviewer then presented the project summaries to the committee, and projects were voted on for funding based on scores and qualitative considerations. Funding decisions were then executed through award agreements, including budget adjustments for project(s) eligibility or feasibility. Geographic diversity and broader benefits were also considered during the selection process.

The DCF allows organizations to reapply after receiving an initial award or after a declined application. Notably, there is no inherent advantage or disadvantage in scoring for past grantees. Declined applicants receive a feedback letter that includes specific strengths and opportunities to improve their project, serving as a valuable resource for future applications. Past grantees are considered based on their potential to contribute added value or innovative aspects beyond their initial award. Some applicants may initially seek modest funding and subsequently apply for increased support as their projects mature, provided they are completed before reapplying. The attainment of milestones and the submission of final reports are required before past grantees can be considered for repeat funding.

According to the reviewer's feedback, the application process is equitable. This sentiment is primarily attributed to the process being divided into a written application and an interview. The interview component allows applicants who may

[8] The DCF has since transitioned its application to an online portal as of the 2022 program year.

have faced challenges in the written section to provide a deeper understanding of their organization's administrative capacities and capabilities. This holistic perspective aids the reviewer in assessing applications more comprehensively.

Financial aid to compensate applicants for the time it takes to fill out their applications is accessible for certain applicants with limited financial resources; however, none of the interviewed grantees were aware of this support.[9] Among the interviewed grantees, only one would have qualified for this assistance. According to the application reviewer, only a small number (four applicants) sought financial application assistance in 2021. Furthermore, the reviewer pointed out that while this funding addresses a "financial gap" among applicants, it does not address the more critical "knowledge-capacity-experience gap." In their view, technical or other forms of application assistance might prove more effective.

> *"Sometimes giving an organization that amount of money isn't as effective as actually providing them that support. When you're an organization without a lot of resources, just getting funds doesn't necessarily give you the capacity to do it, or the knowledge of who to ask to give you that input."*

Most of the interviewed grantees had applied to the DCF in 2020 but were not awarded funding. The DCF team encouraged these applicants to reapply in 2021 and use the feedback provided in 2020 to enhance their applications and improve their chances of securing funding. Grantees were generally satisfied with the application; however, they sometimes struggled with the technical portion. All grantees reported that the application process, including the application form and interview, was relatively uncomplicated to complete. Despite finding the application straightforward, all grantees who had prior experience with grant applications noted its considerable length and the required technical details. Three organizations required third-party assistance from a TE-focused electrical contractor for more complex elements like technical feasibility or specific information about other TE components.

Among the suggestions for improvement, two grantees proposed introducing an initial letter of inquiry step, a concise two-page document preceding the application form, to assess if applicants meet basic program requirements before diving into the full application.

Interviewed grantees recommended establishing standardized technical support, including offering predefined service lists tailored to different project types, aiming to facilitate accessibility for applicants with limited knowledge of TE technologies. For example, for applicants with charging project components, the DCF could provide a list of technical assistance that PGE provides, such as site assessments, building power capacity, network connectivity, installation costs, and maintenance costs. For applicants with an EV project component, this list could include topics such as operational requirements (i.e., daily driving needs, patterns of use), range and battery capacity, total cost of ownership, charging solutions/options (if no accompanying charger is installed), and vehicle performance. Both lists of services could also include options to assist applicants with the technical components of the DCF application and would be in addition to the charging guides and EV purchasing guides that PGE already provides to applicants.

Most grantees we spoke with lacked awareness of the technical assistance provided by the DCF. While the DCF team underscores the importance of providing technical assistance to support projects throughout the application and TE project lifecycle, few applicants were aware of this available support. Particularly, applicants unfamiliar with TE technology may not be informed about technical feasibility requirements, anticipated costs, or the potential need to engage third-party TE-focused contractors for their projects. Consequently, projects without a robust understanding of technical and financial feasibility may receive lower scores than those well-versed in these areas.

[9] Applicant organizations with an operating budget of less than $2 million qualify for this assistance.

A specific technical challenge reported by applicants with charging projects is the mandatory electrical diagram of their building. Numerous submissions were deemed unsatisfactory, as applicants lacked guidance and clarity. There may be an opportunity for the DCF to enhance education and training for applicants, ensuring they receive all essential technical information for a successful application without relying on them to request it explicitly. Based on insights gathered from discussions with grantees, the DCF could provide applicants with supplementary documentation that offers essential technical information. The current qualified chargers list lacks technical details needed by applicants. The recommended supplemental technical documentation should address three key components:

- A detailed overview of how charging infrastructure operates;
- Information on crucial aspects of the electrical diagram that applicants can effectively communicate to contractors; and
- Topics that the PGE team considers in their assessment of the application, such as the connection of chargers to pre-existing electrical panels and site suitability.

By incorporating these elements into the supplemental document, applicants will be better equipped to comprehend and fulfill the technical requirements of the application.

3.4 PARTICIPATION PROCESS

Grantees did not report any issues filling out the quarterly reports required by the DCF. After receipt of funding, the DCF team requires grantees to submit quarterly progress reports throughout their project's lifecycle to ensure the DCF-funded projects adhere to the anticipated timeline. Program staff reported that quarterly reports from 2021 grantees have been submitted intermittently, however, the cadence of grantee submittal has improved with the addition of a grant manager role on PGE's DCF team. None of the grantees we spoke with reported that the quarterly report process was burdensome to their organization.

Projects with an EV purchasing component faced minor difficulties that were overcome with the help of the DCF team. All grantees reported time delays due to the COVID-19 pandemic, where supply-chain issues impacted their timeline, and the rising cost of vehicles impacted their budget. In both cases, the DCF team accommodated the difficulties by providing additional funding and extending the project deadline where necessary.

Almost all grantees with a charging project component worked with the same contractor to assist in installing, operating, and maintaining their chargers. This contractor provided grantees with the technical expertise to complete the charging-related component of their application and/or help with the installation of their charging infrastructure.

All interviewed grantees with a charging project component faced difficulties with installation, operations, or maintenance. All three projects with a charging component had issues installing or maintaining their chargers. One grantee reported they had problems working with their building owner to identify an alternative site for their charger after their initial location was determined to not be feasible. This grantee recommended that PGE offer siting assistance to projects to help identify potential locations for chargers. Additionally, once they decided on a new location, they underwent a "slow and lengthy" approval process with the City of Portland to install their chargers. Another grantee had IT issues when operating the chargers, which they solved with the help of the third-party contractor who originally helped install the chargers. The last grantee with a charging project reported that one of the installed chargers was vandalized, which led them to make their chargers private.

3.5 COMMUNITY IMPACT

All grantees have equity-focused operations that directly support their target priority communities, and all reported that DCF funding has helped them expand these operations. Although grantees did not have specific metrics that they track

to measure the impact of their projects on priority communities, they noted that they had the ability to serve their communities more frequently and at a greater capacity because of DCF funding.

- One grantee mentioned that they have supported the development of car repair businesses by helping them develop EV charging and repair capabilities. One of the repair shops even created a novel position called "EV concierge" because of the grantee's efforts.
- A ME&O-focused grantee noted that since the conclusion of their project, they have seen an increase in the number of low- and moderate-income customers interested in EVs.
- One grantee mentioned that since they installed chargers in their area, more community members, including low-to-moderate-income people, indigenous communities, and communities of color, have been exposed to EVs and charging technology. This grantee also mentioned that community members see EV ownership as being a more attainable goal due to the increased technology in the neighborhood.

> *"I think for the DCF grant specifically, the things that we hear is just mostly gratitude, that we're actually fulfilling what we're saying that we want to happen, that when we're talking about climate change and climate justice and making things better, that we're actually able to as an organization and subsequently as a community take these steps forward.... People see that [purchasing an EV] is not as far off or as unobtainable, but they're seeing like, "Oh, okay. There are tangible, actual changes and solutions that we can participate in very actively."*

- Two grantees reported that adding an EV to their operations enabled ease of transportation without using an employee vehicle. Additionally, it allowed one grantee to expand the number of households it was able to serve due to the increased vehicle capacity. Both grantees felt that it was an added benefit that the vehicle was an EV and did not contribute to increased greenhouse gas emissions.

> *"The more [resources] we can get out and the faster we can get them out, the more agencies we serve, the more families we serve. So really just simply having the capacity and the space to do our job better and make those processes also easier on our staff. It just increases our services overall..."*

All grantees indicated they would not have pursued their respective projects without DCF grants. A few of these grantees reported that they were unaware of other Portland-based programs that provided funding for TE-focused projects and were grateful that the DCF could provide them with the funding to complete their TE project. All grantees reported that their organizations did not have the means to pursue their projects without funding from the DCF.

Integrating successful grantees into PGE's other TE initiatives could be a promising avenue for advancement for both TE adoption and to have additional impact on priority communities. Two program partners shared their belief in the potential to scale successful DCF projects and seamlessly integrate them with PGE's other TE initiatives.

All interviewed grantees expressed a willingness to participate in a knowledge-sharing network after participating in the DCF. One program partner agreed that leveraging the experiences of previous grantees by encouraging them to share testimonials about their DCF journey would be a good strategy to encourage other organizations to apply.

Opinion Dynamics

CONTACT:

Sam Lamos
Managing Consultant
slamos@opiniondynamics.com

BOSTON
PORTLAND
SAN DIEGO
SAN FRANCISCO

All product or company names that may be mentioned in this publication are tradenames, trademarks or registered trademarks of their respective owners.

PGE

Opinion Dynamics

EVALUATION OF PORTLAND GENERAL ELECTRIC'S TRANSPORTATION ELECTRIFICATION PILOT PROGRAMS

2023 ANNUAL REPORT

MARCH 28, 2024

PGE

CONTENTS

TABLES & FIGURES

APPENDICES

I. EXECUTIVE SUMMARY

I.I PILOT SUMMARY AND EVALUATION ACTIVITIES

Portland General Electric (PGE) launched a coordinated set of three pilot programs in late 2018 that encouraged greater electrification of the transportation sector. While each pilot program had its specific activities and immediate targets, they worked together to bring about several overlapping near-term outcomes including increasing customer awareness and use of electric vehicles (EVs), buses, and charging stations to lower barriers to the adoption of EVs. The following summarizes each pilot's objectives and related evaluation activities conducted by Opinion Dynamics ("the team") in 2023. This report provides findings from the fifth and final year of evaluation activities for the pilots.

OUTREACH, EDUCATION, AND TECHNICAL ASSISTANCE (OE&TA) PILOT

- Residential customers: In 2023, PGE sponsored the 2023 Electric Car Guest Drive and EV Charger Exhibit. Prior to 2022, PGE provided outreach to potential EV purchasers and lessees by sponsoring ride-and-drive events, worked with a transportation network company (TNC) to increase adoption of EVs among TNC drivers, exhibited at the Portland International Auto Show, and engaged EV dealerships.[1]
  - Evaluation approach: Surveys with EV owners and residential customers who are considering purchasing a vehicle in the next five years

- Nonresidential customers: Up until 2022, PGE provided technical assistance and education through the OE&TA pilot to customers interested in fleet electrification or workplace charging and provided fleet electrification assessments. These services are now provided through the Business Charging Rebates and Fleet Partner Pilots.
  - Evaluation approach: No evaluation activities occurred in 2023. Previous evaluation activities can be found in the 2019-2022 Annual Reports.

ELECTRIC AVENUE (EA) PILOT

- PGE installed six EA charging sites, consisting of 12 Level 2 (L2) and 22 Direct Current Fast Charging (DCFC) chargers, geographically dispersed throughout its service territory.
  - Evaluation approach: Surveys with EV owners and residential customers who are considering purchasing a vehicle in the next five years

ELECTRIC MASS TRANSIT 2.0 (TRIMET) PILOT

- PGE installed, owns, and operates two bus depot charging stations and one en route charging station, while TriMet procured five electric short-range buses with 200 kWh batteries.
  - Evaluation approach: No evaluation activities occurred in 2023. Previous evaluation activities can be found in the 2019-2022 Annual Reports.

[1] Note that recent sponsorship of the Portland International Auto Show was funded through the DEQ-funded Clean Fuels Program, whereas past sponsorship was through the OE&TA Pilot. Similarly, dealership engagement is now offered through PGE's Residential EV Smart Charging Pilot.

I.2 KEY FINDINGS AND RECOMMENDATIONS

Growing Concern and Uncertainty with EVs: Despite increasing familiarity with EVs since 2021, the share of customers who are considering purchasing an EV or Plug-in hybrid EV (PHEV) is unchanged, likely because of a significant increase in reported concern with EV prices and growing concerns with charging infrastructure and environmental impacts of EVs. After a sharp increase between 2019 and 2021, the share of customers in 2023 who are either considering or intending to purchase an EV or PHEV in the next five years has leveled off (60%, compared to 59% in 2021). During the same time, customers' reported familiarity with EVs and PHEVs has increased. The positive environmental impact of EVs has, and continues to be, the primary motivator for considering an EV; however, while a majority of customers in 2023 perceive EVs as the most environmentally friendly vehicle fuel type, fewer feel this way compared to 2021 (60%, down from 67% in 2021). This is likely because of increased concerns with the environmental impacts of EV batteries (10% indicating this was a concern, up from just 1% in 2021) and continued concerns with vehicle price and available charging infrastructure.

- **Recommendation:** To help alleviate customer concerns with the environmental impacts of EVs, PGE could consider focusing EV outreach and education messaging around addressing concerns with EV battery sourcing and recycling.

Challenges with Increasing Customer Consideration of EVs: Customers who are not considering an EV for their next vehicle may hold misconceptions about EVs and also have unique obstacles to adoption. Compared to other customers, non-considerers are less likely to report that EVs are the most environmentally friendly vehicle, cost less to fuel, and have lower maintenance costs. Interestingly, non-considerers are less concerned about the purchase price of EVs than customers who are considering or intending to purchase one, despite reporting lower household incomes than considerers and intenders. Non-considerers do appear to face some unique barriers to adopting EVs, including being more concerned with their ability to charge at home and the costs of installing charging, in addition to being less likely to have a service outlet near where they park compared to other customers. Intenders and considerers with garages will also likely face barriers to installing charging at their home, as about half report they would need to install an outlet to be able to charge their EV at home.

- **Recommendation:** Findings suggest environmental messaging likely does not resonate as well with some customers who are not considering EVs. PGE should consider changes to EV outreach and education that goes beyond environmental benefits, focusing more on cost savings potential with home charging. It is important to note that customers who are not considering an EV are not a monolithic group. Some customers in this group may be opposed to EVs regardless of potential benefits, whereas others may have legitimate concerns about their ability to install or have access to charging.

Increasing Customer Interest in PHEVs: There may be opportunities for increasing customer adoption of EVs through increased promotion of PHEVs. While overall customer familiarity and consideration of PHEVs remained the same in 2023 compared to 2021, EV and PHEV owners were more likely to report considering a PHEV for their next vehicle (42%, compared to 35% in 2021). Still, fewer than one-fifth (16%) of all customers reported they would be likely to acquire a PHEV for their next vehicle. In 2023, vehicle purchase price remained the main barrier to purchasing or leasing an EV, followed by vehicle range and charging infrastructure. Additionally, EV and PHEV owners in 2023 were considerably more likely to report vehicle purchase price was a barrier to purchasing an EV. As PHEVs are often less expensive than fully electric EVs, increased prices and changes to incentives may be driving increased interest in PHEVs among owners.

- **Recommendation:** Increasing customer consideration and adoption of PHEVs could help bridge the gap between gas and fully electric fueled vehicles. PGE could consider changes to marketing to better differentiate fully electric EVs and PHEVs, highlighting the lower vehicle purchase prices for PHEVs and increasing range. Consider also

including at least one PHEV at upcoming ride and drive events to allow customers to compare the two types of vehicles.

EV-related Information and Resources: PGE EV-related resources and campaigns have limited reach but were helpful to EV owners when they made their purchase decisions. Customers report receiving information about EVs from a variety of sources, primarily through friends and colleagues, in addition to general internet research. In 2023, customers ranked PGE as the fifth most useful source of EV information among all sources of information they have seen (out of 18 sources of information). Similar to previous surveys, about one-quarter of customers in 2023 reported being aware of at least one PGE EV-related resource or campaign, with EV owners being about twice as likely to report being aware than non-EV owners (53% vs. 24%). Among EV owners who have been exposed to PGE's EV-related information or resources, two-thirds (66%) indicated that the information or resources were at least moderately influential in their decision to purchase an EV. Notably, fewer than one-third (30%) of EV owners reported being aware of PGE's Residential EV Smart Charging Pilot although nearly all (96%) reported charging at home and about two-fifths (42%) report setting charging schedules.

- **Recommendation:** Continue EV-related outreach and education efforts to residential customers as it has been useful, especially to EV owners. Consider focusing on efforts on increasing awareness of PGE's Residential EV Smart Charging Pilot to both current and potential EV owners, as findings suggest there is an opportunity to increase enrollment among existing EV owners.

Equity: An analysis of survey data uncovered key differences among low-income customers, renters, and persons of color in terms of transportation hardship (i.e., living in a high emissions area, ability to afford car payments, access to transportation, and proximity to grocery stores), familiarity with EVs, perceptions of EVs, and barriers to adoption. Low-income customers, renters, and persons of color experience greater transportation hardship than other customers, with low-income customers being the most likely to indicate any transportation-related hardship. Low-income customers are also least likely to be familiar with EVs, and along with renters are least likely to report that they will purchase an EV for their next vehicle. Further, low-income customers, renters, and persons of color were more likely to categorize certain characteristics of EVs (access to charging, costs of charging, vehicle safety, maintenance costs) as "major concerns," indicating that these groups face some unique barriers to adoption. Access to charging is a particularly high barrier.

- **Recommendation:** PGE should prioritize TE-related outreach and education efforts towards low-income customers, renters, and persons of color, as there are continued misconceptions around owning an EV and the potential benefits among these customers. PGE's DEQ-funded Clean Fuels Program provides an excellent opportunity to both expand access to TE and provide outreach and education to underserved communities. PGE should continue to leverage the Program to support targeted education campaigns focused on the features of EVs that are part of a typical car-buying decision and help ease concerns about the technology.

PGE's Electric Avenues and Additional Public Charging Infrastructure: Lack of public charging infrastructure continues to be one of biggest barriers to increasing customer consideration of EVs. In 2023, customer awareness of PGE's EA sites decreased significantly, with fewer than one-fifth (14%) reporting being aware (down from 25% in 2021 and 33% in 2019). Similarly, the proportion of EV owners who reported using an EA site decreased in 2023, with about one-quarter (26%) of EV owners having charged their EV at PGE's EA sites (compared to 38% in 2021). It is possible that some customers who are using EAs do not associate the sites with PGE due to limited PGE marketing or newer EV owners are more inclined to use other public charging networks that may be promoted through their vehicle manufacturer.

Among customers who indicated they were not considering an EV for their next vehicle, about one-third (29%) mentioned that additional charging infrastructure may encourage them to purchase or lease an EV in the future, suggesting a continued need for community charging infrastructure. Further, about one-third (36%) of non-EV owners who indicated that their current parking situation is a major barrier to EV adoption reported that having access to on-street pole-mounted charging would increase their likelihood of considering an EV.

- **Recommendation #1:** Consider increasing the promotion of EA sites to increase customer awareness and help alleviate customer concerns about public charging infrastructure availability. Consider upgrading existing EAs to allow for 150 kW or above charging speeds to better align with current offerings from other charging networks.
- **Recommendation #2:** Consider installing additional community charging infrastructure in commercial areas and residential areas where street parking is more common.

2. INTRODUCTION

2.1 TRANSPORTATION ELECTRIFICATION PILOT BACKGROUND

PGE launched a coordinated set of pilot programs in late 2018 to encourage greater electrification of the transportation sector. While each pilot program had specific activities and targets (Table 1), they were intended to work together to bring about overlapping near-term outcomes: (1) PGE customers would learn about, see, and use EVs, buses, and charging stations, helping to lower barriers to the adoption of EVs; (2) Multifamily and low-income customers would have better access to EV transportation; and (3) Businesses, municipalities, and governmental agencies would receive technical assistance and education to improve their ability to support an EV-ready infrastructure and encourage adoption of EV fleets.[2]

Table 1. Description of PGE's Pilot Activities

Outreach, Education, and Technical Assistance Pilot (OE&TA)
This pilot has relied on the following strategies to increase the adoption of EVs in PGE's territory: ▪ EV technical assistance to commercial and industrial customers, municipalities, governmental agencies, nonprofit organizations, mass transit agencies and providers, low-income service providers, and community-based organizations (CBOs) that are considering fleet electrification, workplace charging, or procurement of EVs ▪ EV ride-and-drive events ▪ Educational kiosks and education of auto dealer staff on a proprietary EV charger labeling system and mobile application for EV drivers who reside in PGE territory ▪ Partnerships with original equipment manufacturers (OEMs) (i.e., BMW, Chevrolet, and Nissan) to offer combined PGE and OEM incentives for an EV to PGE customers (referred to as "bulk purchase partnerships") ▪ Partnerships with transportation network companies (TNCs) to educate drivers about the benefits of driving EVs and increase EV utilization through discounted charging initiatives
Electric Avenue Pilot
PGE installed six EA charging sites geographically dispersed throughout its service territory. The pilot tested pricing signals to encourage off-peak charging and charging when excess renewable energy is available. The pilot also examined the impact of community charging on increasing adoption of EVs by PGE customers (including multifamily residents) and TNC drivers.
Electric Mass Transit 2.0 ("TriMet") Pilot
PGE owns two bus depot charging stations (150 kW each) and one en route charging station (450 kW). TriMet procured five electric buses with 200 kWh batteries. The pilot gathered bus charging data from the stations to assess the energy and cost impacts of electrifying an entire bus route over time and the impacts on TriMet operations.

2.2 EVALUATION OBJECTIVES AND ACTIVITIES

This report is the fifth and final annual report as part of a five-year evaluation and covers pilot activities that began in late 2018 and continued through December 2023. There are three primary objectives of the five-year evaluation:

[2] Fleet electrification and technical assistance are now offered through PGE's Fleet Partner.

- Understand how PGE can improve its program implementation during and after the pilots;
- Quantify the impacts of the pilots on EV awareness, sales, use, and barriers; and
- Determine the load impacts of Electric Avenue and electric bus chargers.[3]

This report covers the final year of evaluation activities, which included the third wave of the General Population Residential Customer and EV Owner Survey.

2.2.1 WAVE 3 GENERAL POPULATION RESIDENTIAL AND EV OWNER SURVEY

In 2018, PGE conducted a baseline survey (Baseline) with the general population of residential customers who indicated they were considering purchasing a vehicle within five years to assess EV awareness and perceptions. In 2019, the team adapted the 2018 Baseline survey to create a post-pilot launch survey. The first wave of the post-pilot launch survey ("Wave 1") was conducted in 2019, the second wave ("Wave 2") was conducted in 2021, and the third wave ("Wave 3"), summarized below, was conducted in August and September 2023.

For Wave 3, the team invited a random sample of 16,000 PGE residential customers with email addresses to take the Wave 3 survey. Customers who completed the survey entered a drawing to win one of six gift cards (one valued at $500 and five valued at $100 each). Additionally, the team invited an oversample of 15,745 residential customers who potentially owned or leased an EV or PHEV to take the Wave 3 survey and respond to questions about their EVs. Customers who completed the survey were entered into a drawing to win one of six gift cards (one valued at $250 and five valued at $50 each).

The team conducted the Wave 3 survey using the same methodology as the previous surveys. The survey included questions about pilot awareness, consideration of purchase, and intention to purchase or lease an EV or PHEV, as well as questions explicitly addressing the pilot activities, such as whether customers are familiar with any pilot campaigns. The Wave 3 survey also included additional questions to understand EV owner characteristics and behavior.

Table 2 provides a disposition summary of completed surveys for the Baseline, Wave 1, Wave 2, and Wave 3 general population and EV owner surveys. Overall, 929 (54%) of Baseline, 1,026 (59%) of Wave 1, 1,179 (53%) of Wave 2, and 975 (61%) of Wave 3 general population survey respondents reported planning to purchase a vehicle in the next five years and completed the survey. Among the Wave 3 oversample of EV owners, 2,718 (99%) respondents reported owning an EV and were valid respondents for analysis purposes. Section 4 provides a summary of findings from Wave 3 respondents and an overall comparison to Baseline, Wave 1, and Wave 2 survey respondents. A detailed discussion of the survey sampling, screening criteria, and survey weighting approach can be found in Appendix A.

[3] Note that load impacts of Electric Avenue and electric bus chargers can be found in the 2020 and 2022 Annual Reports.

Table 2. Disposition Summary of Baseline, Wave 1, Wave 2, and Wave 3 Surveys

			Total Completed Screening Questions	Total Screened Out	Valid Respondents	Overall Response Rate
Baseline (2018)	General Population	Ct.	1,736	807	929	8%
		%	100%	47%	54%	
Wave 1 (2019)	General Population	Ct.	1,752	726	1,026	11%
		%	100%	41%	59%	
Wave 2 (2021)	General Population	Ct.	2,209	1,030	1,179	15%
		%	100%	47%	53%	
	EV Owner Oversample	Ct.	2,284	333	1,951	25%
		%	100%	15%	85%	
	Total	Ct.	4,493	1,363	3,130	20%
		%	100%	30%	70%	
Wave 3 (2023)	General Population	Ct.	1,605	630	975	10%
		%	100%	39%	61%	
	EV Owner Oversample	Ct.	2,748	30	2,718	17%
		%	100%	1%	99%	
	Total	Ct.	4,353	660	3,693	14%
		%	100%	15%	85%	

3. OPUC LEARNINGS

PGE provides the Oregon Public Utilities Commission (OPUC) with learnings associated with each pilot as part of the effort to monitor the progress of the pilots.[4] Table 3 through Table 5 (below) provide findings associated with the OPUC learnings by pilot. Note that the key findings are derived from the 2019, 2020, 2021, 2022, and 2023 evaluation activities, and details for some findings are presented in the 2019, 2020, 2021, and 2022 evaluation reports.

3.1 OUTREACH, EDUCATION, AND TECHNICAL ASSISTANCE PILOT

Table 3. Outreach, Education, and Technical Assistance Pilot OPUC Learnings Key Findings

OPUC Learning	Key Findings
1. The impact of outreach efforts (e.g., ride-and-drive events, education) and marketing (e.g., ads), if available, on;	▪ Early ride-and-drive dealership events were of mixed success and could be improved with additional promotional support from PGE for future ride-and-drive events. ▪ Ride-and-drive events appear to be increasing in popularity. The 2022 event was the largest of the three events where the research team fielded intercept surveys. At the first surveyed event in November 2019, four vehicles were available to drive, 47 people attended, and 30 test drove vehicles. At the 2022 event, 10 vehicles were available, 252 people attended, and 136 test drove vehicles. ▪ The Portland International Auto Show has been an effective venue for educating people interested in EVs and is more cost-effective than ride-and-drives.

[4] Report on Finalized Learnings for PGE's Transportation Electrification Programs (2018): *https://apps.puc.state.or.us/orders/2018ords/18-124.pdf*

OPUC Learning	Key Findings
1a. PGE customer awareness of EVs in the service area as measured through PGE customer surveys, focus groups, one-on-one interviews, program data, etc.;	In 2023, four-fifths of customers reported being familiar with EVs (81%) or PHEVs (81%). Familiarity with EVs in 2023 was consistent with the 2021 Wave 2 survey, which was significantly higher than the 2019 Wave 1 and 2018 Baseline surveys.
1b. The consideration of an EV for new car shoppers; and,	▪ Dealers say that EV educational kiosks help to explain EVs to new-car shoppers and alleviate their concerns regarding range and where and how to charge. ▪ In 2023, few (13%) EV owners reported being shown an EV educational kiosk while visiting a PGE partner dealer. ▪ In 2023, about half (52%) of customers who are likely to purchase a vehicle during the next five years report they would "definitely" or "probably" consider purchasing an EV. Consideration of EVs in 2023 was consistent with the 2021 Wave 2 survey, which was significantly higher than the 2019 Wave 1 (39%) and 2018 Baseline (38%) surveys.
1c. Overall sales and leases of EVs in the service area as measured through the evaluation of recent EV purchasers/lessees.	EV market growth is documented by PGE internally for Distribution System Plan Updates.
2. The impact of technical assistance programs and marketing on the installation of workplace EV chargers.	Results from all three waves of the surveys suggest technical assistance from PGE was influential in the decision to install workplace charging (64% of respondents indicated PGE's technical assistance was at least moderately influential).
2a. Number of recipients of technical assistance that result in charger installations.	Three-fifths of technical assistance survey respondents (60%) who provide on-site parking have installed chargers or outlets for charging since receiving assistance. Five respondents indicated in the follow-up survey that they had installed additional workplace chargers since completing the initial survey.
3. The change to participation rates in TOU rate schedules by EV owners.	A TOU rate specifically for EV owners was envisioned as part of the OE&TA pilot but has not been adopted by PGE. Other PGE evaluations of time-varying rates for all residential customers and PGE's Residential EV Smart Charging Pilot will analyze impacts on EV owners and other customer segments.
4. The change in EV charging load characteristics influenced by education efforts.	
5. The major challenges business customers face when planning for and siting EV charging infrastructure.	Business customers noted a variety of challenges, including the installation taking more time to complete than expected, stations not working as intended, and permitting taking longer than expected.
5a. Evaluate the efficacy of outreach effort, including challenges; and,	Customers had positive feedback about their consultations via the UM1811 pilot. PGE could improve its ability to evaluate the efficacy of its outreach by systematically tracking data on customers' experiences, including whether they have purchased EVs or installed charging equipment as a result of their consultations.[a]
5b. Adjustments to outreach efforts to increase effectiveness and response to barriers.	Most customers reached out to PGE about their consultation needs. A PGE contact indicated that outreach efforts could be improved by tracking data about customers' needs and knowledge of EVs to improve future outreach efforts.
6. Gather data on customer awareness of EVs and their exposure to PGE's EV marketing campaigns.	▪ The well-attended Portland International Auto Show has engaged customers and is likely more effective in educating people interested in EVs than ride-and-drives. ▪ Similar to the 2021 Wave 2 and 2019 Wave 1 survey, about one-quarter (24%) of the 2023 Wave 3 survey of likely vehicle purchasers reported seeing at least one PGE EV resource, campaign, or discount. ▪ TNC drivers primarily learned about PGE's EAs by driving past an EA site or using an EA charger. Drivers mentioned that EA charging sites and subscription services should be more widely marketed to drivers to increase awareness and participation.
7. Develop and implement a plan to gather sample information from a variety of populations in PGE's service territory, including those listed below:	Evaluation meets this requirement.
7a. General sample of PGE customers;	Evaluation meets this requirement.
7b. Recent EV purchasers;	Evaluation meets this requirement.

OPUC Learning	Key Findings
7c. Recent technical assistance customers;	Evaluation meets this requirement.
7d. Recent non-EV purchasers;	Evaluation meets this requirement.
7e. Trade allies (e.g., dealers, manufacturers); and,	Evaluation meets this requirement.
7f. Key stakeholders (e.g., ride-and-drive implementer, transportation authorities, program staff).	Evaluation meets this requirement.

[a] Since initiation of the OE&TA pilot, PGE has launched the Fleet Partner pilot, which systematically tracks customer progress through the planning and building phases of fleet electrification projects, including EVs procurement.

3.2 EA PILOT

Table 4. EA Pilot OPUC Learnings Key Findings

OPUC Learning	Key Findings
1. Effect of EV charging on PGE's system to determine how EVs can be used to create a system benefit	EV charging has a minimal impact on PGE's bulk and distribution systems due to customer responsiveness to peak pricing periods. At full capacity, each charging site would only increase the feeder load by 1% to 2%, which is not enough to trigger distribution system capacity studies.
2. The impact of the presence of visible, reliable, and accessible charging infrastructure on:	
2a. Customers' willingness to purchase an EV; and,	▪ Similar to 2021 Wave 2 results, one-fifth of 2023 Wave 3 non-EV owners reported their next vehicle will be an EV, which is an increase from the 2018 Baseline and 2019 Wave 1 surveys (19% in Waves 2 and 3, up from 14% of Wave 1 and 7% of Baseline). In 2023, customers were equally likely to report they intend to purchase an EV (19%) or PHEV (16%) as a gasoline-fueled vehicle in the next five years (35% compared to 36%, respectively). ▪ TNC drivers who live in multifamily buildings without charging are less likely to purchase another EV due to a lack of charging infrastructure. Further, TNC drivers had concerns about charger availability and range and, therefore, said they were less likely to purchase another EV in the future. ▪ The availability of PGE's EAs had a moderate influence on EA users' decision to purchase or lease EVs. Findings from the 2022 EA Survey show about half (52%) of users who were aware of PGE's EAs prior to purchasing their EV indicated PGE's EAs were either "somewhat" or "very" influential in their decision to purchase or lease their vehicles.
2b. Customers' willingness to take longer trips in an EV.	Even with improved charging infrastructure, customer expectations for vehicle battery range have increased over time. In 2023, over one-half (58%) of customers who mentioned "minor" or "major" concerns with vehicle range would need a battery range of over 250 miles to alleviate range concerns.
3. To the extent possible, learning who the predominant users of the charging infrastructure are:	Although there was a 324% increase in EA non-subscribers between 2020 and 2022, EA subscribers consumed more energy over the analysis period (894 MWh) than non-subscribers (565 MWh). On a per-customer basis, subscribers use 2–3 times more energy per month than non-subscribers, potentially because they are more likely to live in multifamily homes than non-subscribers (per EA survey responses) and rely more heavily on public charging.
3a. Whether there are distinct use cases with predictable load profiles;	▪ Over the analysis period, the charging load profile of EA monthly subscribers peaked just before peak pricing began (around 3:00 p.m.) and exhibited a rebound peak just after peak pricing ended (around 8:00 p.m.). ▪ This behavior was not observed in the non-subscriber charging profile, which peaked during mid-day and did not have a rebound after peak pricing ended. This behavior was also not observed by any user group on weekends when peak pricing was not in place.
3b. Whether the chargers are regularly utilized by non-PGE customers; and	EA sites are primarily utilized by PGE customers, with over three-quarters (76%) of 2022 EA User Survey respondents indicating they are PGE customers.
3c. If possible, use by and effects of TNCs.	▪ One TNC company offered its drivers a discounted subscription pricing plan for EA charging, which ended in September 2020. In 2020, PGE reported that the Downtown Portland and East Portland EA sites were popular with TNC drivers, suggesting that drivers utilize the pricing plan and the EA network. The 2020 EA impact analysis confirmed that the East Portland EA was most popular with TNC drivers; however, user group data were unavailable for the Downtown Portland EA. These sites are likely popular due to their central location and relative proximity to the airport. ▪ TNC drivers aggregately consumed an average of 1,879 kWh per month, approximately 19% of total EA charging between March 2019 and October 2020.

OPUC Learning	Key Findings
4. Utilization and/or demand for quick chargers versus L2 chargers, including the time of day and pricing information.	▪ DCFCs have higher utilization than L2 chargers. Interviews with PGE staff revealed that customer demand for L2 chargers still exists among EA users; however, charging and utilization data suggest that customers prefer DCFC. During the analysis period, DCFCs served 94% of energy delivered by EA chargers. In addition, the DCFC utilization rate, when excluding Downtown Portland, was 7.2%, nearly twice that of L2 chargers. ▪ The daily usage patterns of L2 and DCFC chargers exhibit differences: the daily average DCFC load profile exhibits two peaks with a dip between 3:00 p.m. and 8:00 p.m., during peak pricing, while the L2 average charging profile only peaks once around noon. The impact of peak pricing is not observable in the L2 average charging profile. ▪ The two types of chargers are not equally used by all user groups. EA non-subscribers use 7.5% of total energy at L2 chargers, while subscribers only use 4.1% of total energy at L2 chargers. ▪ TNC drivers want to see additional fast chargers at the Downtown Portland and Beaverton EA sites. Drivers most commonly charge at these locations and would like more charging ports to increase EV charging turnover.
5. To the extent possible, learning who is not using the charging infrastructure and why.	▪ Multifamily building owners, managers, and tenants have limited awareness of EAs and do not currently have a large demand for charging. ▪ Lack of awareness is a major barrier to using the charging infrastructure. Awareness of PGE's EAs dropped in 2023, with about one-tenth (14%) of Wave 3 non-EV owners and one-third (31%) of Wave 3 EV owners aware of PGE's EAs. Of those EV owners who were aware, about one-quarter (26%) reported using at least one EA location (down from 38% in the 2021 Wave 2 survey). ▪ EA sites are disproportionately used by multifamily residents. Surveyed EA users were considerably less likely to report living in single-family homes compared to EV owners in PGE's service territory (64% compared to 92%).
6. Network load profiles and the impacts on PGE's distribution system, including coincident and noncoincident peak loads of DCFCs and power quality in the vicinity of the chargers.	▪ Over the analysis period, charging load at six EA sites had minimal impact on PGE's distribution system.[a] None of the feeders at the EA sites were at risk of overloading even when all chargers were used simultaneously. ▪ EA charging load is not observed to be highly coincident with PGE's system peak. For all EA sites combined, the non-coincident peak (NCP) ranged from 194 kW to 501 kW month by month after all charging stations were online, which is about 15%–19% of the total charging capability. As for the coincident peak, on average, 48 kW of charging happens during the top 3% of PGE load hours, approximately 4% of the total charging capability.
6a. Gathering of information to assist with analysis of impacts to PGE's system, including how many users are charging off-peak and how that affects the system.	▪ Over the analysis period, 29% of charging occurred during the off-peak period, 53% occurred during the mid-peak period, and 19% occurred during the peak period.[b] ▪ Most (71%) surveyed EA users indicated charging outside of EA peak hours, and nearly two-thirds (60%) reported being aware of the $0.19/kWh peak charge.
7. A comparison of customer use of charging infrastructure under time-variant rates versus free charging.	The $0.19/kWh peak charge from 3:00 p.m. to 8:00 p.m. on weekdays has an observable impact on the charging load shape and has helped shift the charging away from the system peak period. Over the analysis period, an estimated 62.2 MWh of peak period charging for the Beaverton, East Portland, Hillsboro, Milwaukie, and Wilsonville EAs was shifted to off-peak hours or approximately 66.4 kWh/day.
7a. Gathering of information to assist with analysis of whether price signals change charging behavior and why or why not.	A depressed on-peak charging pattern was observed across all EA sites. On average, 16% of charging occurs during the peak pricing period. EA subscribers are even more responsive to peak pricing and only use 12% of total energy charged during the peak pricing period, as opposed to 22% of total energy charged by non-subscribers.
8. Impact of, and customer interest in, unlimited monthly charging versus other pricing options (e.g., single use, who uses, behavior).	▪ Although still minor in scope, the unlimited monthly charging pricing plan may have an adverse effect on popular EA sites where congestion occurs because drivers have no incentive to unplug and move on once charging is complete. If the adverse effect persists, an alternative pricing structure may be warranted. The impact analysis found that more than three chargers were in simultaneous use 16% of the time between 8:00 a.m. and 8:00 p.m. at the Downtown Portland site, indicating that the most popular sites may experience some congestion.

OPUC Learning	Key Findings
	▪ PGE staff reported potentially adjusting the EA subscription model as EV customers become more accustomed to per-minute or per-kWh charging. Some customers have complained that the current pricing structure is restrictive and expensive, especially for those who are not consistent EA users or are only charging for a short time. ▪ EA monthly subscribers show observable responses to peak pricing, which is not observed in the charging profile of non-subscribers. ▪ Surveyed EA users provided mixed opinions on preferred EA pricing options. Nearly equal numbers of survey respondents reported they would prefer to pay for just the amount of energy they used (37%) as would prefer a monthly subscription (35%). The remaining respondents prefer flat rate charging (28%). Nearly all (85%) survey respondents who preferred to pay for the amount of energy they used currently pay a flat rate for EA charging. ▪ About two-thirds (61%) of EA users reported they would like to have the option to pay for EA charging on their home electric bill.
9. The additional PGE infrastructure, if any, needed to support and ensure highly reliable public charging infrastructure and associated costs.	▪ In 2021, PGE staff noted that EA charger downtime continued to be an issue; however, increased communication between vendors and PGE had improved service across sites. PGE developed a new service level agreement (SLA) with their charger vendor that includes a performance improvement plan to improve charging network reliability. ▪ 2022 TNC driver focus group participants indicated that they had noticed that EA uptime had generally improved; however, they would like to see greater consistency across charging sites. Drivers mentioned that real-time input on apps such as PlugShare and Shell Recharge would enable PGE to identify and resolve issues quickly. ▪ TNC drivers also reported that additional charging ports are needed at current EA sites, such as Downtown Portland and Beaverton, and additional EA sites are needed in the Tigard and Lake Oswego areas. Drivers would like to increase their driving range and, therefore, need additional charging stations across Portland and adjacent areas. ▪ Responses from surveyed EA users suggest a need for improved charger reliability, the ability to reserve a charger, additional amenities (e.g., shelter from the elements, lighting, restrooms nearby), and additional chargers in the Portland metropolitan area.

[a] Six EA sites include Beaverton, East Portland, Hillsboro, Milwaukie, Salem, and Wilsonville.

[b] Off-peak, mid-peak, and on-peak periods are defined based on PGE's residential TOU tariffs: https://portlandgeneral.com/energy-choices/energy-choices-home/time-of-use-pricing-home.

3.3 ELECTRIC MASS TRANSIT 2.0 (TRIMET) PILOT

Table 5. Electric Mass Transit 2.0 (TriMet) Pilot OPUC Learnings Key Findings

OPUC Learning	Key Findings
1. Pilot design elements, including an exploration of:	
1a. Program implementation (pricing and suppliers);	▪ An electric bus manufacturer supplied five short-range buses to TriMet for $930,000 each (including warranties and upfitting). ▪ A transit-charging vendor supplied the charging systems for a total cost of $789,000 for equipment. ▪ TriMet estimated the total make-ready cost (installation, engineering, design, and permits) for both charging systems was $787,670.
1b. PGE physical infrastructure and cost (line extension, line drop, and distribution equipment requirements); and,	▪ At Merlo Garage, transformer pads and primary power connections were designed to ensure larger transformers and additional secondary runs could be accommodated in the future. ▪ The Sunset Transit Center has capacity for a second 450 kW charger.
1c. Customer service and technical assistance needs.	▪ TriMet trained its drivers on bus operation and charging and trained its dispatchers so their advice to operators matched their bus. ▪ PGE and TriMet determined the scope of operations and maintenance (O&M) to include routine maintenance, emergency repair, on-site spare parts, and monitoring services. ▪ PGE monitored charger operation and informed TriMet and, if needed, the charging vendor of any problems. ▪ PGE advised TriMet on the build-out of its Powell Garage chargers. ▪ In 2020, PGE reported needing greater communication and more timely responses when contacting the charging vendor with questions related to the charging dashboard. ▪ Driver shortages and ridership declines due to COVID-19 hindered bus service.
2. Actual impacts of bus charging load on system infrastructure:	No feeder or substation upgrades were required for the Merlo Garage and Sunset Transit Center charging stations.
2a. Additional infrastructure and cost, if any, needed to support and ensure reliable bus charging infrastructure	
3. Actual impacts of bus charging load on the distribution system loading:	▪ Neither the Sunset Transit Center nor the Merlo Garage feeders are at risk of overloading despite the use of high-powered chargers. ▪ In 2022, loading in the summer on the feeders serving Merlo Garage and Sunset Transit Center was 59% and 45% of its rated capacity, respectively. This is below the threshold that would trigger a capacity study by PGE.
3a. Total load and non-coincident peak (NCP) load compared to feeder loading; and,	▪ Over the study period, the NCP load at the Sunset Transit Center ranged from 185 kW to 421 kW. The NCP load at Merlo Garage was typically around 150 kW–300 kW in months when the buses were operating. ▪ The charging capacity (450 kW) of the Sunset Transit Center represents about 2.5% of the feeder's capacity. The charging capacity (300 kW) at Merlo Garage represents about 1.7% of the feeder's capacity, showing that bus charging contributes very little to feeder loading.
3b. Coincident peak demand, summer and winter of combined depot chargers.	▪ Charging demand during bulk system peak hours is generally low compared to the capacity of chargers. Over the study period, charging load during the top 3% of system peak hours ranged from 17%–23% (126 kW–179 kW) in summer and 10%–19% (51 kW–140 kW) in winter across the analysis period.[a] ▪ Coincident peak load on the distribution system was generally low. The Merlo Garage charging load averaged less than 16 kW, or 5% of the chargers' capacity, in the top 3% of feeder load hours. Sunset Transit Center's average load during summer peak hours was 118 kW, or 26% of the en-route charger's capacity. During winter, the average load during peak hours was 67 kW.

OPUC Learning	Key Findings
4. Actual impacts to the bus fleet and fleet facility, of which TriMet will provide some information.	▪ As of 2021, all pilot buses had performance issues affecting reliability and availability. One bus, in particular, experienced battery and wiring issues that caused it to be out of service throughout 2021. In 2021, all five short-range buses were in operation for less than 10% of the year. ▪ COVID-19 heavily impacted ridership and bus driver availability. Due to these impacts, TriMet staff expected at least a 10% decrease in service. ▪ TriMet staff reported that replacement of bus components and repairs are more common with electric buses than diesel buses. TriMet staff are still trying to understand the cadence at which components need to be replaced based on use and age. ▪ Between 2019 and 2020, buses were occasionally grounded due to issues connecting to the en-route charger: a bolt in a mechanical component fell out, causing connection issues. The charging equipment vendor has since rebuilt the en-route charger. Significant maintenance events on the en-route charger have continued to lead to periods of reduced service by the buses. ▪ Analysis of the most frequent errors with the en-route charger indicated that misalignment of the bus and the pantograph and interlock failure were the two most common errors.
4a. How does the integration of chargers impact the internal logistics of route planning? (Benefits and costs to operations).	TriMet is currently piloting several long-range buses that only require depot charging to limit unreliable en-route charging. Note these new long-range buses are not included in the scope of this evaluation.
4b. How does their optimal schedule for charging align with system load?	The charging load did not contribute significantly to PGE's system peak during the study period; however, the team observed a high variation of average peak demand during the system peak hours due to the variation of buses' arrival time at Sunset Transit Center. Therefore, higher than normal demands in power charging at the Sunset Transit Center could occur by chance during PGE's peak hours in the future.
4c. How flexible is their charging need such that it could better align with system loading?	Charging flexibility for electric buses is based on battery capacity (short- vs. long-range) and route length. Given the use of short-range buses and the route configuration, there is little flexibility to shift charging to off-peak times.
4d. TriMet staff feedback on operations and charging compared to existing fleet resources	In 2020, TriMet staff noted that operators enjoyed the buses because of their performance and quietness.
4e. Total combined costs from PGE and TriMet, including charging infrastructure installation, operation, and maintenance costs	See 1a above for charging and infrastructure costs.
5. PGE's initial deployment with TriMet will include TOU rates with demand charges (through Schedule 85-P). PGE intends to study system impacts on peak days, evaluate the bus charging use case, and assess the customer's needs.	Through 2022, over three-quarters (78%) of charging occurred during the on-peak period of Schedule 85, the tariff the Sunset Transit Center and Merlo Garage are on. Eighty-two percent of charging at Sunset Transit Center occurred during the peak period, which is defined as 6:00 a.m. to 10:00 a.m., Mondays through Saturdays. This is largely unavoidable, as those are the typical hours when the buses are operating and making frequent stops at the en-route charger. Less on-peak charging occurred at the Merlo Garage; however, 54% of charging load occurred during the on-peak period.

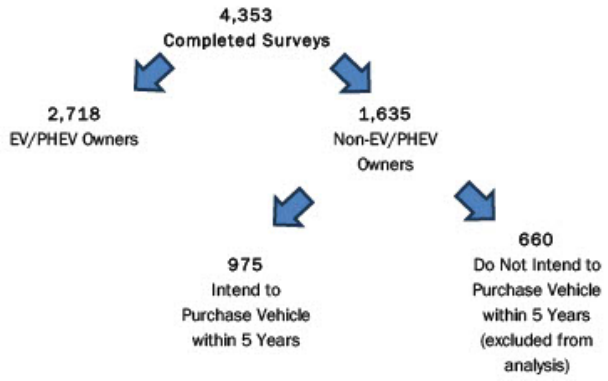
[a] Excludes summer 2020 and winter 2020–2021 when buses were out of service for long periods of time.

4. GENERAL POPULATION RESIDENTIAL CUSTOMER AND EV OWNER SURVEY FINDINGS

This section presents key findings from Wave 3 of the general population survey fielded to PGE residential customers and potential EV owners in August and September 2023. Additionally, where questions are comparable, this section includes comparisons to the Baseline survey fielded in 2018, the Wave 1 survey fielded in 2019, and the Wave 2 survey fielded in 2021. The survey included questions about pilot awareness, consideration of EV purchase, and intention to purchase or lease an EV, as well as questions specifically addressing the pilot activities and EV owner characteristics.

In the Wave 3 survey, 4,353 customers completed survey screening questions, of which 2,718 customers (62% of all respondents) reported owning or leasing an EV or PHEV. Among non-owners, 975 customers (60%) indicated they would likely purchase a vehicle within the next five years (Figure 1). The remaining 660 non-owners (18% of all respondents) reported they do not intend to purchase a vehicle within the next five years and were excluded from the analysis.

Figure 1. Survey Respondents' Intent to Purchase any Vehicle within Five Years



The survey results are presented by breaking out the respondents into four segments: three non-EV/PHEV owner segments—EV/PHEV non-considerers, EV/PHEV considerers, and EV/PHEV intenders (see Table 6 for definitions of each segment)—and the EV/PHEV owner segment. Note that when comparing the results of the Baseline, Wave 1, Wave 2, and Wave 3 surveys, the team excluded EV owners to be consistent with previous years.[5] In the analysis of the Wave 3 survey, the team included current EV owners as a separate segment, including a comparison to Wave 2 EV owners. The team conducted statistical testing to detect significant differences between the segments and survey waves.

[5] In 2018, PGE conducted a baseline survey with a general population of residential customers who indicated they were considering purchasing a vehicle in the next five years to assess EV awareness and perceptions in the PGE territory. Opinion Dynamics adapted the 2018 Baseline survey to create a post-pilot launch survey. The first wave of the post-pilot launch survey ("Wave 1") was conducted in 2019. A third wave of the post-pilot launch survey ("Wave 3") was conducted in 2023. Only the Wave 2 and Wave 3 surveys include oversamples of EV owners.

The share of customers intending to purchase an EV or PHEV in the next five years has continued to increase since the Baseline surveys, although the rate of increase slowed between the Wave 2 and Wave 3 Surveys. About twice as many customers intend to purchase an EV or PHEV in the next five years compared to the baseline survey (17% compared to 35%; Table 6). The share of respondents who would not consider an EV remained consistent in Wave 3 after a significant decrease in Wave 2.

Table 6. General Population Customer Survey Analysis Segments

Segment and Definition		Baseline (2018)		Wave 1 (2019)		Wave 2 (2021)		Wave 3 (2023)	
		n	%	n	%	n	%	n	%
All likely vehicle purchasers	PGE Residential customers who indicate that they expect to purchase or lease a new or used vehicle within the next five years	929	100%	1,026	100%	1,179	100%	975	100%
EV/PHEV Non-Considerers	Likely Vehicle Purchasers who indicate they are not planning to consider an EV or PHEV for their next vehicle purchase	494	53%	526	51%	488	41%*	385	40%
EV/PHEV Considerers	Likely Vehicle Purchasers who indicate they will consider an EV or PHEV for their next vehicle but selected another type of vehicle when asked which one type they are most likely to acquire the next time they purchase or lease a vehicle	276	30%	253	25%*	312	27%	246	25%
EV/PHEV Intenders	Likely Vehicle Purchasers who selected EV or PHEV when asked: "Considering everything you currently know, which one type of vehicle listed below are you most likely to acquire the next time your household purchases or leases a vehicle?"	159	17%	247	24%*	379	32%*	344	35%*

* Indicates a statistically significant difference between the previous survey wave (z-test for proportions, $p < .05$).

4.1 CUSTOMER FAMILIARITY AND CONSIDERATION OF EVS

4.1.1 FAMILIARITY

Customers continue to have moderate to high levels of familiarity with EVs and PHEVs. The familiarity with EVs increased significantly since the Wave 1 and Baseline surveys (81% of Wave 3 customers reported being "somewhat" or "very familiar" with EVs, up from 73% and 76%, respectively). In contrast, customer familiarity with PHEVs remained consistent across survey waves (Figure 2). Customers who own EVs or PHEVs exhibited greater familiarity with all vehicle fuel types than non-owners.

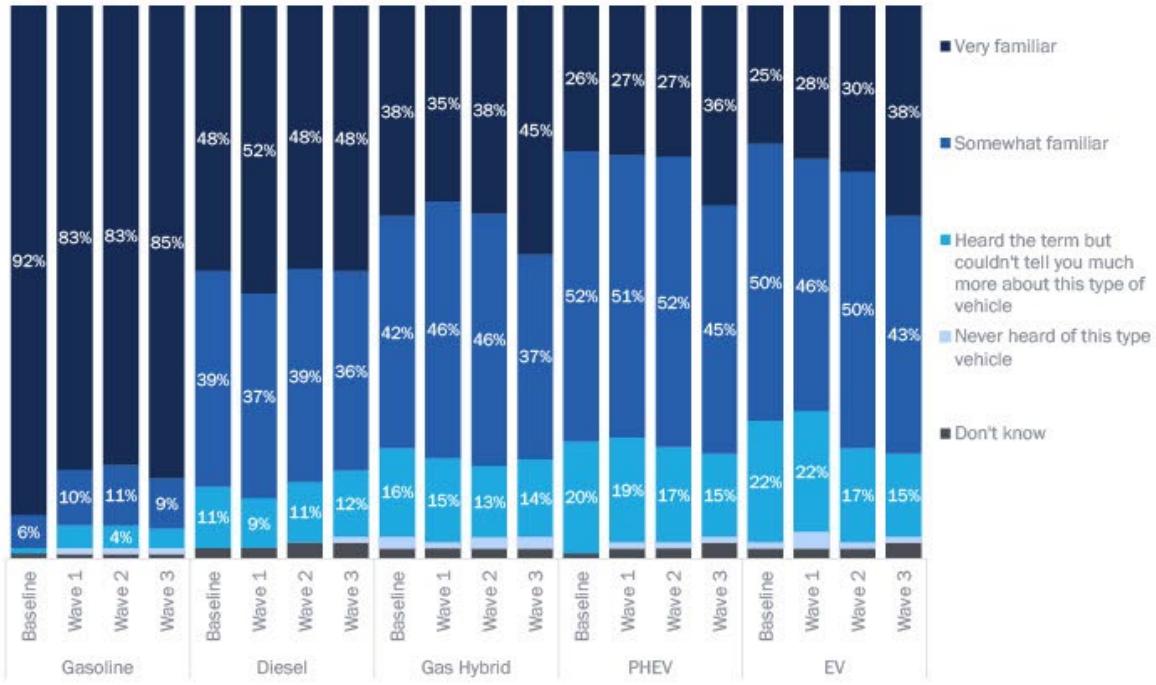
Figure 2. Respondent Familiarity with Vehicle Fuel Types by Survey Wave and Segment (Multiple Responses Allowed)

Familiarity with Different Vehicle Type	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
Gasoline	97% B C D	93%	94%	94%	99%	99%	93%	94%	96%	99% A B C
Diesel	87%	89% D	86%	85%	92%	91%	80%	89% A	87% A	91% A
Hybrid	80%	82%	84%	82%	97%	96%	71%	90% A	90% A	96% A B C
Plug-in hybrid	78%	78%	80%	81%	96%	96%	70%	86% A	90% A	96% A B C
All electric	76%	73%	80% A B	81% A B	100% B	99%	71%	86% A	90% A	99% A B C
Biodiesel	57%	62% A D	58%	57%	71% B	67%	51%	56%	65% A	67% A B
Natural gas	38%	39%	40%	37%	53% B	46%	34%	36%	41%	46% A B

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

Non-EV owners exhibit lower familiarity levels with EVs and PHEVs compared to gasoline and diesel vehicles, although familiarity has increased over time. Consistent with prior waves, non-EV owners were significantly less likely to report being "very familiar" with EVs and PHEVs compared to gasoline and diesel vehicles (Figure 3). Compared to the Baseline survey, the proportion of non-EV owners who reported being "very familiar" with EVs and PHEVs increased significantly.

Figure 3. Non-EV Owner Level of Familiarity with Vehicle Fuel Types, by Survey Wave (Baseline n=929; Wave 1 n=1026; Wave 2 n=1179; Wave 3=975)



4.1.2 PERCEPTION OF VEHICLE ENVIRONMENTAL FRIENDLINESS, FUEL COSTS, AND MAINTENANCE COSTS

While a majority of customers perceive EVs as the most environmentally friendly vehicle fuel type, fewer feel this way compared to previous survey waves. About three-fifths (60%) of respondents reported that EVs are the most environmentally friendly vehicle fuel type, a significant decrease from 67% of Wave 2 survey respondents (Figure 4). Non-considerers were significantly less likely to report that EVs or PHEVs are the most environmentally friendly compared to the other segments. Further, Wave 3 EV owners were significantly less likely to report EVs are the most environmentally friendly vehicle fuel type compared to Wave 2 (84%, down from 93% in Wave 2).

Figure 4. Respondents' Perception of Environmental Friendliness by Vehicle Fuel Type, Survey Wave, and Segment (% Reporting 8–10)

Environmental Friendliness of Vehicle Type	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
All electric	68% D	69% D	67% D	60%	93% B	84%	42%	67% A	79% A B	84% A B C
Plug-in hybrid	43% D	45% C D	39% D	34%	31%	32%	22%	42% A D	44% A D	32% A
Hybrid	29% C D	28% D	25%	23%	13%	14%	22% D	25% D	25% D	14%
Natural gas	23% C D	22% C D	18% D	14%	11%	10%	16% C D	17% C D	10%	10%
Biodiesel	17%	19% C D	15%	14%	9%	10%	14%	17% D	12%	10%
Diesel	3%	4%	6% A	4%	2%	2%	6% C D	4%	2%	2%
Gasoline	3%	3%	5%	5%	1%	2% A	8% B C D	4%	2%	2%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

Similarly, most customers associate EVs with the lowest fuel costs, followed by PHEVs (Figure 5). EV owners were most likely to report that EVs have the lowest fuel costs compared to the other customer segments with non-considers being the least likely. Interestingly, there was a notable increase in respondents reporting gas hybrids having the lowest fuel costs compared to previous waves.

Figure 5. Respondents' Perception of Fuel Costs by Vehicle Fuel Type, Survey Wave, and Segment

Perception of Lowest Fuel Cost	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
All electric	58%	54%	59% B	58%	91% B	89%	45%	58% A	74% A B	89% A B C
Plug-in hybrid	15% D	15% D	14%	11%	3%	3%	9% D	13% D	13% D	3%
Hybrid (non-plug-in)	5%	6%	6%	10% A B C	1%	1%	16% C D	11% C D	2%	1%
Natural gas	7%	6%	5%	5%	2%	2%	5% D	7% C D	3%	2%
Gasoline	2%	3%	4% A	5% A B	1%	1%	8% C D	6% C D	1%	1%
Don't know	7%	8% C D	6%	5%	1%	1%	9% B C D	1%	2%	1%
Biodiesel	3%	4%	3%	3%	1%	1% A	4% D	3%	3%	1%
Diesel	2%	3% D	3% D	1%	1%	1%	2%	0%	1%	1%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

Consistent with previous survey waves, about one-third (32%) of the Wave 3 respondents indicated that EVs have the lowest maintenance costs. However, more Wave 3 respondents (29%) reported that gasoline vehicles have the lowest maintenance costs compared to previous waves (21% for both Waves 1 and 2) (Figure 6). EV owners were significantly more likely to report that EVs have the lowest costs compared to the other segments, especially compared to non-considerers.

Figure 6. Respondents' Perception of Maintenance Costs, by Vehicle Fuel Type Survey Wave, and Segment

Perception of Lowest Maintenance Cost	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
All electric	29%	32%	34% A	32%	93% B	90%	15%	30% A	55% AB	90% ABC
Gasoline	25% BC	21%	21%	29% ABC	2%	3%	37% CD	31% CD	18% D	3%
Hybrid (non-plug-in)	2%	4%	4%	7% ABC	0%	1%	9% CD	9% CD	3% D	1%
Diesel	6%	8%	7%	6%	1%	1%	7% D	7% D	3% D	1%
Plug-in hybrid	5%	6%	5%	4%	1%	1%	5% D	5% D	4% D	1%
Natural gas	3%	3%	3%	2%	0%	0%	4% CD	2%	1%	0%
Biodiesel	1%	1%	2%	1%	0%	0%	1%	0%	1%	0%
Don't know	28% CD	26% D	24% D	19%	3%	4% A	23% CD	16% D	15% D	4%

4.1.3 CONSIDERATION OF EVS AND USED VEHICLES

Customer consideration of EVs and PHEVs for their next vehicle has remained consistent. Respondents who reported that they were likely to purchase a vehicle during the next five years were asked about the fuel types of vehicles they would "definitely" or "probably" consider purchasing. Approximately half of Wave 3 survey respondents are likely to purchase an EV (51%), which is similar to Wave 2 (52%), though higher than Wave 1 (39%) and the Baseline (38%) surveys (Figure 7). Fewer respondents reported that they would consider purchasing a gas vehicle in Wave 3 compared to Wave 2 (61% vs. 66%). Additionally, there has been an increase in interest among EV owners in PHEVs (42%, compared to 35% in Wave 2).

Figure 7. Respondent Fuel Type Consideration for Next Vehicle, by Vehicle Fuel Type, Survey Wave, and Segment (Multiple Responses Allowed)

Likelihood to Consider Vehicle Type (% Reporting Definitely or Probably Consider)	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1383) (A)	Wave 3 (n=1746) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=1746) (D)
Gasoline	79% B C D	74% C D	66% D	61%	18%	16%	78% B C D	69% C D	34% D	16%
All electric	38%	39%	52% A B	51% A B	94%	92%	0% †	81% A	93% A B	92% A B
Hybrid	42% B	37%	43% B	44% B	20%	23%	28%	69% A C D	47% A D	23%
Plug-in hybrid	39% B	33%	42% B	43% B	35%	42% A	0% †	76% A D	75% A D	42% A
Diesel	15% C D	13% C D	9%	9%	4%	3%	15% B C D	5%	3%	3%
Biodiesel	8%	9% D	7%	6%	2%	2%	6% D	6% D	5% D	2%
Natural gas	6%	7%	7%	6%	2%	2%	6% D	8% D	5% D	2%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons. The proportion of considerers who are considering EVs or PHEVs is less than 100%; however, the sum of customers in the considerers segment who are considering EVs and PHEVs is greater than 100%, as customers could be considering both EVs and PHEVs.

† Significant testing was not performed on these fuel types because responses were used in defining the EV/PHEV non-considerers segment.

When deciding about their next vehicle, about half (54%) of customers who are at least considering purchasing an EV would consider a used or pre-owned EV or PHEV. Just over half of considerers (58%) and intenders (51%) reported they would "definitely" or "probably" consider a used or pre-owned EV or PHEV. Customers reported they would consider a used or pre-owned EV/PHEV primarily because the vehicle would be more affordable (81%) or because they prefer to purchase used vehicles (29%). Among customers who indicated they would not consider a used or pre-owned EV/PHEV, about half (54%) reported having concerns with battery life, followed by not normally purchasing used vehicles (40%), having concerns about vehicle range (35%), not being able to get incentives for a used EV or PHEV (28%), and having concerns about resale value (10%; multiple responses allowed).

4.1.4 INTENT TO ACQUIRE

We asked survey respondents who would consider purchasing a fuel type for their next vehicle which one they would be most likely to acquire.

The share of customers who will purchase an EV as their next vehicle is unchanged from Wave 2 though it is significantly higher compared to the Wave 1 and Baseline surveys (19% of Waves 2 and 3, up from 14% of Wave 1 and 7% of Baseline; Figure 8). Additionally, the combined percentage of customers who are likely to report that they intend to purchase an EV (19%) or PHEV (16%) is equal to that of a gasoline-fueled vehicle (35% and 36%, respectively). EV/PHEV

intenders are slightly more likely to report that they will purchase an EV compared to a PHEV (56% vs. 44%) as their next vehicle. Compared to Wave 2, Wave 3 owners are slightly less likely to purchase an EV (71% vs. 76%) as their next vehicle and slightly more likely to purchase a PHEV (15% vs. 12%).

Figure 8. Vehicle Fuel Type Respondents are Most Likely to Acquire for their Next Vehicle Purchase or Lease by Vehicle Fuel Type, Survey Wave, and Segment

Next Vehicle Type	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=921) (A)	Wave 1 (n=1016) (B)	Wave 2 (n=1157) (C)	Wave 3 (n=965) (D)	Wave 2 (n=1377) (A)	Wave 3 (n=1740) (B)	EV/PHEV Non-Considerers (n=375) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=1740) (D)
Gasoline	56% BCD	46% CD	36%	36%	3%	4%	67% BCD	32% CD	0%	4% C
All electric	7%	14% A	19% AB	19% AB	76% B	71%	1%	0% †	56% AB	71% ABC
Hybrid (non-plug-in)	15%	14%	14%	19% ABC	3%	4%	18% CD	45% ACD	0%	4% C
Plug-in hybrid	11%	10%	15% AB	16% AB	12%	15% A	1% B	0% †	44% ABD	15% AB
Don't know	7%	12% AD	12% AD	8%	5%	5%	8% C	18% ACD	0%	5% C
Diesel	3%	3%	3%	2%	1%	1%	3% CD	2% C	0%	1% C
Biodiesel	0%	1%	1%	1%	0%	0%	1%	1%	0%	0%
Natural gas	0%	0%	1% A	1% A	0%	0%	1%	2%	0%	0%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons. A small percentage (3%) of respondents in the EV/PHEV non-considerers segment indicated they would most likely purchase an EV or PHEV for their next vehicle, even though they indicated they were not considering an EV or PHEV for their next vehicle.

† Significant testing was not performed on these fuel types because responses were used in defining the EV/PHEV Non-Considerers segment.

4.2 SOURCES OF INFORMATION ABOUT EV ACQUISITION, OWNERSHIP, AND CHARGING

Non-EV owners receive information about EVs from a variety of sources, with PGE being a key source of information. Respondents reported primarily receiving information about EVs from friends and colleagues (50%), which is consistent with previous surveys (Figure 9). Similar to Waves 1 and 2, about one-quarter (22%) of Wave 3 respondents reported receiving information about EVs from PGE. Slightly more EV owners in Wave 3 compared to Wave 2 reported receiving information from PGE about EVs (17% vs. 13%).

Figure 9. Sources Respondents Recalled Reading, Hearing, or Seeing Information about EVs by Survey Wave and Segment (Multiple Responses Allowed)

Sources of EV Information	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
Friends and colleagues	48%	48%	50%	50%	53%	54%	42%	50%	60% ABD	54% A
General internet search	30%	30%	34% A	40% ABC	58%	60%	30%	45% A	49% A	60% ABC
Social media	26%	26%	30% A	36% ABC	25%	28%	35% D	36% D	38% D	28%
Automobile manufacturers	31%	29%	28%	31%	36%	36%	24%	31%	38% A	36% A
Automobile dealerships	22%	20%	21%	23%	17%	19% A	16%	26% AD	29% AD	19%
Portland General Electric (PGE)	32% BCD	23%	25%	22%	13%	17% A	15%	29% AD	26% AD	17%
Automobile reviews and information in consumer advice publications / webs	28% D	25% D	24%	21%	41% B	35%	16%	19%	30% AB	35% AB
Environmental organizations	20% B	15%	17%	17%	18%	16%	15%	15%	19%	16%
Automobile websites	16%	16%	16%	15%	29%	28%	10%	16% A	21% A	28% ABC
Automobile magazines	19% BD	15%	16% D	12%	18%	18%	8%	14% A	17% A	18% A
U.S. Department of Energy (DOE)	8%	5%	6%	7%	6%	9% A	6%	4%	10% B	9% B
Reddit	4%	5%	4%	7% AC	12%	14% A	5%	10% A	9% A	14% AC
U.S. Environmental Protection Agency (EPA)	9% B	6%	7%	6%	6%	8% A	5%	5%	9%	8% AB
Electrical contractors	1%	1%	1%	2%	1%	2% A	2%	2%	1%	2%
Forth	2%	2%	2%	2%	7% B	4%	1%	3%	2%	4% AC
Some other source	1%	5% A	5% A	5% A	5%	5%	6%	4%	3%	5%
None of the above	8% D	10% D	8% D	5%	2%	2%	8% CD	5% C	2%	2%
Don't know	10% B	8%	10% B	11% B	6%	5%	15% BCD	8%	8%	5%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

When we asked non-EV owners which source of information they found most useful, PGE ranked fifth (12%) among all sources of information, with friends and colleagues (36%), general internet searches (35%), automobile reviews (19%), and automobile manufacturers (14%) rounding out the top five most useful information sources.

4.3 MOTIVATIONS AND BARRIERS TO PURCHASING OR LEASING AN EV OR PHEV

This section provides information about customer motivations to purchase an EV or PHEV, barriers to adoption, and the likely changes needed to address customer concerns and increase the likelihood of purchasing an EV.

4.3.1 MOTIVATIONS

Environmental impact and fuel or operating costs continue to be the primary reasons motivating customers to purchase or lease an EV. In an open-ended response, over one-third (37%) of non-EV owners mentioned environmental impact, and over one-quarter (28%) mentioned fuel or operating costs as reasons for purchasing or leasing an EV (Figure 10). Almost two-thirds (61%) of Wave 3 owners reported the environmental impact as the primary reason for purchasing, significantly more than all other segments.

Figure 10. Unprompted Reasons Mentioned for Purchasing or Leasing an EV or PHEV by Survey Wave and Segment (Multiple Responses Allowed)[a]

Main Reason ForPurchasing/Considering an EV/PHEV (unprompted)	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Consideres (n=385) (A)	EV/PHEV Consideres (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
Environmental impact	42%	40%	42%	37%	62%	61%	23%	45% A	49% A	61% A B C
Fuel/operating cost	33% B C D	26% C	12%	28% C	16%	30% A	27%	28%	29%	30%
No/less gas used	5%	8% A	18% A B	15% A B	21% B	17%	15%	13%	16%	17%
Cost	11%	9%	10%	10%	12%	17% A	7%	8%	15% A B	17% A B
Ease/availability to charge	0%	0%	0%	4% A B C	0%	7% A	4%	5%	5%	7% A
Other	0%	0%	0%	4% A B C	0%	4% A	6%	3%	3%	4%
Less maintenance	0%	0%	0%	3% A B C	0%	13% A	2%	2%	4%	13% A B C
Efficiency/fuel economy	7% D	5%	5% D	3%	4%	4%	3%	5%	2%	4%
Maintenance costs	8% D	8% D	7% D	3%	27% B	12%	3%	3%	4%	12% A B C
Improved range	4% B C D	2%	2%	3%	4% B	1%	3%	1%	4% B D	1%
Don't know	2%	27% A	25% A	24% A	2%	2%	33% C D	25% C D	11% D	2%

Notes: Current EV owners were asked, "What are the main reasons you purchased or leased an all-electric/plug-in hybrid electric vehicle?" Those who indicated they were intending to purchase an EV or PHEV were asked, "What are the main reasons you would consider an EV PHEV for your next vehicle purchase or lease?" All other respondents were asked, "If in the future you were to consider purchasing or leasing an EV /PHEV, what would you expect to be the main benefits of having an electric vehicle?"

a Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

Similarly, when provided with a list of potential reasons for considering or purchasing or leasing an EV or PHEV, nearly all (80%) non-EV owners indicated environmental protection was a "major" reason (Figure 11). EV owners were significantly more likely than non-EV owners to report less vehicle maintenance (64% vs. 54%), vehicle performance (57% vs. 49%), and convenience of charging at home (68% vs. 53%) as major reasons for purchasing an EV. EV owners were significantly less likely to report the availability of charging in PGE's territory (Portland and Salem metropolitan areas) as a major reason to purchase an EV compared to non-EV owners (14% vs. 35%), potentially because they have greater access to home charging (68% indicated that charging at home is a major reason why they purchased an EV).

Figure 11. Prompted Reasons for Purchasing or Leasing an EV/PHEV by Survey Wave and Segment (Multiple Responses Allowed)

Reasons For Purchasing/Considering EV/PHEV (% Reporting as Major Reason)	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners		
	Baseline (n=435) (A)	Wave 1 (n=500) (B)	Wave 2 (n=691) (C)	Wave 3 (n=590) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
Protecting the environment	78%	82%	86% A D	80%	85% B	79%	72%	86% B D	79% B
Number of miles vehicle will go on a single charge	N/A[a]	N/A[a]	N/A[a]	79%	N/A[a]	67%	80% D	79% D	67%
Lower fuel cost	82% B C D	70%	64%	77% B C	64%	72% A	78%	77%	72%
Vehicle safety	68% D	64%	64%	62%	60% B	53%	65% D	59% D	53%
Less vehicle maintenance required	63% C D	58%	53%	54%	64%	64%	53%	56%	64% B C
The convenience of charging my vehicle at home	68% B C D	49%	46%	53% C	70%	68%	46%	59% B	68% B C
Vehicle's performance and handling	61% C D	55%	53%	49%	64% B	57%	52%	47%	57% C
Tax incentives and rebates	41% B C	32% C	25%	39% B C	32%	32%	41% D	39% D	32%
Availability of public charging stations in the Portland/Salem metro areas	56% B C D	31%	35%	35%	17% B	14%	38% D	33% D	14%
Availability of public charging stations outside of the Portland/Salem metro areas	55% B C D	30%	33%	33%	30% B	26%	35% D	32% D	26%
The convenience of charging my vehicle at work	26% B C D	17%	17%	21%	10%	9%	22% D	19% D	9%
Priority parking at some locations	10%	9%	8%	9%	3%	2%	14% C D	6% D	2%
How I look driving and owning this vehicle	5%	6%	4%	8% A C	8%	7%	11%	6%	7%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons. EV/PHEV Non-Considerers were not asked this question. Those who indicated they were intending to purchase an EV or PHEV were asked, "For each of the factors below, please indicate whether that factor is a major reason, a minor reason, or not a reason you are considering an all-electric vehicle/plug-in hybrid electric vehicle for your next purchase/lease." EV owners were asked, "For each of the factors below, please indicate whether that factor was a major reason, a minor reason, or not a reason you decided to purchase or lease an all-electric vehicle / plug-in hybrid electric vehicle."

[a] Item not displayed to Baseline, Wave 1, or Wave 2 survey respondents.

4.3.2 BARRIERS AND CHANGES NEEDED TO INCREASE EV ADOPTION

Compared to previous survey waves, Wave 3 EV owners and non-owners are significantly more concerned with the affordability of EVs. In an open-ended response, nearly half (45%) of non-EV owners and nearly one-third (30%) of EV owners mentioned that cost or affordability is the top barrier to purchasing or leasing an EV or PHEV, significantly higher than in previous survey waves (Figure 12). There was also a slight increase in the number of mentions related to the availability of charging stations (23%, up from 19% in Wave 2 for non-EV owners and 22%, up from 19% for EV owners). Wave 3 non-EV owners were also more concerned about range or battery life (19%, up from 14% in Wave 2), and the negative environmental impacts of EVs (10%, up from 1% in Wave 2). Interestingly, customers in the intender segment were significantly more likely to report cost or affordability as barriers compared to non-considerers and owners (52% vs. 38% and 30%, respectively), likely because customers in these segments have spent more time researching EVs and understand the costs compared to conventional vehicles. In contrast, EV owners could likely afford these costs as they generally have higher incomes (see Section 4.8).

Figure 12. Unprompted Barriers Mentioned to Purchasing or Leasing an EV or PHEV by Survey Wave and Segment (Multiple Responses Allowed)

	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
Reasons For Not Considering EV/PHEV (Unprompted)	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
Cost/affordability	31% BCD	32%	29%	45% ABC	22%	30% A	38% D	45% D	52% AD	30%
Recharge stations/infrastructure	22% B	13%	19% B	23% BC	19%	22% A	27% CD	24%	18%	22%
Range/battery life	25% BCD	18% C	14%	19% C	23%	23%	19%	21%	18%	23% C
Environmental impacts(batteries etc)	6% C	5% C	1%	10% ABC	0%	2% A	17% BCD	8% D	4%	2%
Cost of repairs/maintenance	8% C	6%	4%	7% C	1%	1%	9% D	6% D	5% D	1%
Convenience/ease of use	7% CD	7% CD	3%	4%	3%	5% A	7% C	4%	2%	5% C
Availability of more electric cars	17% BCD	9% CD	3%	3%	2%	3% A	1%	3%	7% ABD	3% A
Lack of familiarity	5% BCD	2%	2%	2%	0%	0%	4% D	2%	2%	0%
Power/able to pull and tow	4% CD	4% CD	1%	1%	1%	2% A	3% BC	0%	0%	2% BC
Nothing/ don't know	0%	19% A	27% ABD	16% A	36% B	32%	14%	18%	16%	32% ABC

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons. The team added "Don't know" as a response option beginning in the Wave 1 survey; hence, the responses for Wave 1 and Wave 2 are significantly higher compared to the Baseline.

Opinion Dynamics 31

Similarly, when provided with a list of potential concerns about purchasing or leasing an EV or PHEV, a large majority of non-EV owners reported that the purchase price of the vehicle was a major concern. Non-EV owners' concern about the vehicle purchase price increased significantly between Wave 2 and Wave 3 (85%, up from 77% in Wave 2; Figure 13). Wave 3 customers in the considerer segment were significantly more likely to report the following as major concerns compared to customers in the intender segment: vehicle purchase price, maintenance costs, time to charge, charging cost, and costs to equip or upgrade home electricity.

Figure 13. Prompted Barriers Mentioned to Purchasing or Leasing an EV/PHEV by Survey Wave and Segment (Multiple Responses Allowed)

Barriers to Purchasing or Leasing an EV/PHEV (% Reporting a Major Concern)	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
Purchase price of vehicle	79% BCD	84% AC	77%	85% AC	57%	65% A	81% D	89% AD	87% D	65%
Number of miles vehicle will go on a single charge	86% BCD	78%	80%	76%	72%	70%	76% D	82% CD	72%	70%
Vehicle Reliability	N/A[a]	77% D	76%	73%	71%	72%	68%	77% A	76% A	72%
Amount of time required to charge battery	66%	62%	63%	64%	46%	46%	72% BCD	63% CD	53% D	46%
Ability to charge at home	66%	65%	63%	63%	67%	67%	69% C	60%	59%	67% BC
Vehicle safety	69% D	66%	65%	62%	61%	59%	59%	64%	64%	59%
Maintenance costs	65% C	61%	57%	62%	33%	37% A	63% CD	68% CD	55% D	37%
Availability of public charging stations outside of the Portland/Salem metro areas	69% BCD	61%	62%	58%	49%	48%	69% BCD	56% D	47%	48%
Concerns about cost to upgrade electrical panel to install home charger	N/A[a]	N/A[b]	N/A[c]	52%	N/A[c]	11%	68% BCD	53% CD	33% D	11%
Vehicle's performance and handling	64% BCD	58% D	56% D	50%	52%	51%	46%	54%	51%	51%
Availability of public charging stations in the Portland/Salem metro areas	61% BCD	50%	51%	49%	25%	26%	59% BCD	45% D	39% D	26%
Cost of charging the vehicle	54% BCD	45%	42%	49% C	20%	26% A	53% CD	56% CD	39% D	26%
Cost of installing home charging station	N/A[a]	N/A[b]	45%	48%	6%	8% A	64% BCD	48% CD	28% D	8%
Environmental concerns about electric vehicle production	N/A[a]	N/A[b]	N/A[c]	41%	N/A[c]	18%	50% BCD	39% D	31% D	18%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

[a] Item not displayed to Baseline survey respondents.

[b] Item not displayed to Baseline or Wave 1 survey respondents.

[c] Item not displayed to Baseline or Wave 2 survey respondents.

Among customers who indicated they were not considering an EV or PHEV for their next vehicle, one-third (33%) reported they could not name anything that would convince them to purchase or lease an EV or PHEV. Just under one-third (29%) suggested that additional charging infrastructure may encourage them to purchase or lease an EV or PHEV in the future (Figure 14). Additional charging infrastructure has consistently been the most needed change over the four survey waves.

Figure 14. Unprompted Reported Changes Necessary to Consider EV or PHEV for Next Vehicle among Non-Considerers, by Survey Wave (Multiple Responses Allowed) [a]

Changes Needed to Potentially Consider EV/PHEV	All Likely Vehicle Purchasers			
	Baseline (n=494) (A)	Wave 1 (n=526) (B)	Wave 2 (n=488) (C)	Wave 3 (n=385) (D)
Nothing	3%	30% A	29% A	33% A
Additional charging stations/infrastructure	32% B	25%	33% B	29%
Cost/affordability	23% B	16%	18%	19%
Range/battery life	24% C D	21% C	8%	16% C
Battery	5% C	4% C	1%	9% B C
Charge time	7%	6%	5%	9% C
Cost of vehicle	8% C	7% C	0%	7% C
Style/model of car	24% B C D	16% C D	6%	3%
Grid reliability	0%	0%	1% A B	2% A B
Vehicle size	7% C D	6% C D	3% D	0%
Don't know	8%	5%	14% A B D	5%

Note: Letters indicate statistically significant differences between survey waves (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.
[a] Only asked of respondents in the EV/PHEV Non-Considerer segment. The team added "Nothing" as a response option beginning in the Wave 1 survey; hence, the responses for Wave 1, Wave 2, and Wave 3 are significantly higher compared to the Baseline.

Customer expectations of vehicle battery range have remained stable between the Wave 2 and Wave 3 surveys. Over half (58%) of customers who cited the "number of miles vehicle will go on a single charge" as a "minor" or "major" concern with purchasing an EV/PHEV reported that EVs would need a battery range of over 250 miles to alleviate range concerns (Figure 15). Customers who own an EV/PHEV were considerably more likely to report needing a vehicle with a battery range of over 250 miles compared to non-owners (73% vs. 58%). Non-considerers were significantly more likely than other customers to want a vehicle with more than 300 miles of range.

Figure 15. Number of Miles EV Needs to Go on Single Charge to Reduce Range Concerns, by Survey Wave and Segment

Miles Needed on a Single Charge to Reduce Vehicle Range Concerns	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=888) (A)	Wave 1 (n=971) (B)	Wave 2 (n=1115) (C)	Wave 3 (n=915) (D)	Wave 2 (n=1848) (A)	Wave 3 (n=2583) (B)	EV/PHEV Non-Considerers (n=346) (A)	EV/PHEV Considerers (n=240) (B)	EV/PHEV Intenders (n=329) (C)	EV/PHEV Owners (n=2583) (D)
100 miles or less	8%	11% A D	10% D	7%	2%	2%	5% D	7% D	8% D	2%
101 to 200 miles	22% D	23% C D	19% D	15%	7%	8% A	11%	17% D	17% A D	8%
201 to 250 miles	15% C	15% C	10%	15% C	15%	16%	10%	19% A	18% A	16% A
251 to 300 miles	22%	19%	20%	19%	30%	31%	15%	16%	25% A B	31% A B C
More than 300 miles	29%	28%	37% A B	39% A B	45%	42%	50% B C D	38% C	28%	42% C
Not sure	5%	4%	5%	6%	2% B	1%	9% B C D	4% D	4% D	1%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons. Question displayed only to those who reported "number of miles vehicle will go on a single charge" was a "minor" or "major" concern.

4.4 EV OWNER CHARACTERISTICS AND BEHAVIOR

This section provides a profile of the EV owners who responded to the survey, including their vehicle and usage type as well as charging behavior. It also examines EV-related knowledge and awareness of the general population compared to EV owners. We provide results from the Wave 2 and Wave 3 surveys when meaningful comparisons exist.

4.4.1 VEHICLE TYPE AND YEAR PURCHASED, AND PRIMARY USE

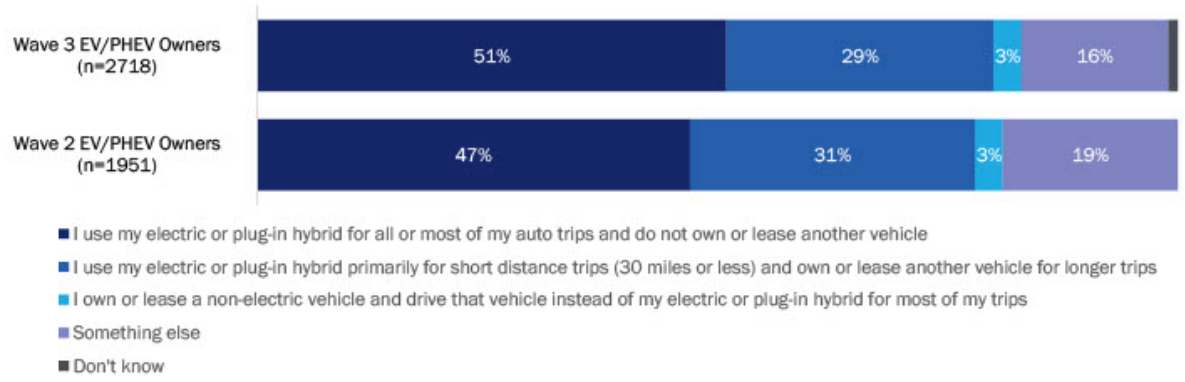
Of the 3,451 EVs and PHEVs that customers reported owning, a large majority are EVs (91%), and only about one in ten (9%) are PHEVs. About two-fifths (43%) of the reported vehicles were manufactured by Tesla. Chevrolet (10%), Nissan (10%), Hyundai (6%), Ford (5%), and Toyota (5%) round out the top six of the most reported manufacturers. As shown in Figure 16, the majority of EVs or PHEVs were purchased in the two years before each wave. A total of 46% of EVs and PHEVs owned by Wave 3 respondents were purchased in 2022 or 2023, while 40% of EVs and PHEVs owned by Wave 2 respondents were purchased in 2020 and 2021.

Figure 16. EV or PHEV Purchase Year

4.4.2 PRIMARY EV USE AND EXPECTED USE

More than half of EV owners reported using their EVs or PHEVs for all or most of their trips and that they did not own another vehicle (Figure 17). The percentage of owners exclusively using an EV increased significantly from Wave 2 (51% in Wave 3, up from 47% in Wave 2). Among those who said something else, most indicated using an EV or PHEV for most of their trips, but also have a non-electric vehicle available.

Figure 17. Typical Use of EV/PHEVs by EV Owners



Most non-EV owners who are considering (56%) or intending (66%) to purchase an EV or PHEV would likely use the vehicle for all or most of their trips and would not own another vehicle (Figure 18).

Figure 18. Type of Potential EV Use

Type of Potential EV Use	All Likely Vehicle Purchasers			Wave 3 - All Likely Vehicle Purchasers	
	Wave 1 (n=500) (B)	Wave 2 (n=691) (C)	Wave 3 (n=590) (D)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)
I would use an electric or plug-in hybrid for all or most of my auto trips and would not own or lease another vehicle	63% C	57%	61%	56%	66% B
I would use an electric or plug-in hybrid primarily for short distance trips (30 miles or less) and own or lease another vehichle for longer trips	26%	28%	25%	29%	22%
I would use a non-electric vehicle instead of an electric or plug-in hybrid for most of my trips	4%	7% B	7% B	10%	6%
Other	1%	2%	1%	1%	1%
Don't know	6%	6%	5%	4%	5%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). Only asked of respondents in the EV/PHEV considerer and intender segments.

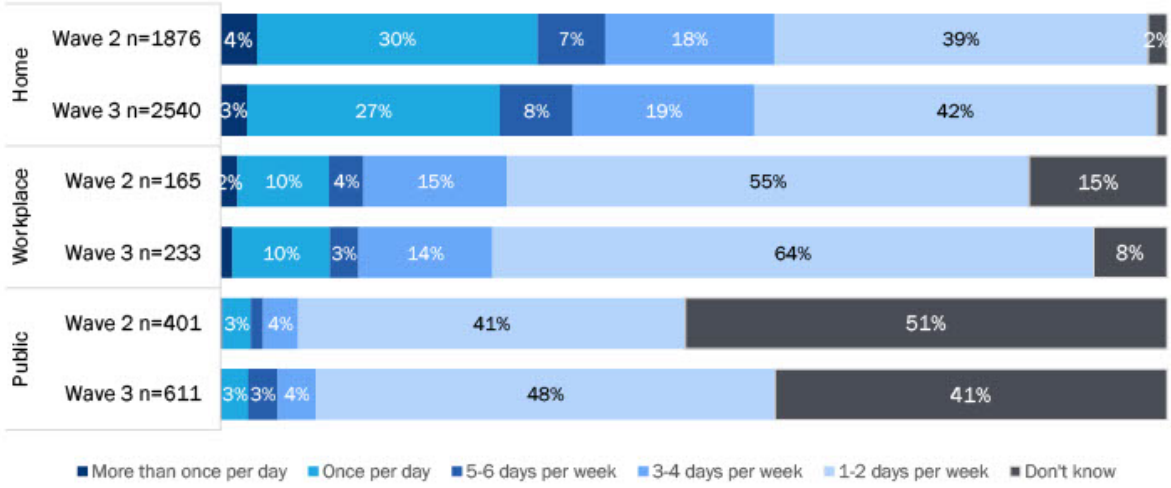
4.4.3 EV CHARGING

EV owners most commonly charge their EVs at home. Consistent with Wave 2 findings, nearly all (93%) Wave 3 EV owners reported typically charging at home, and about one-fifth (22%) reported using public chargers (Figure 19). Among EV owners who charge at home, about three-quarters (73%) reported using a Level 2 charger, while about one-third (30%) reported using a Level 1 charger (multiple responses allowed). Additionally, about one-third (30%) reported programming their EV/PHEV to start and stop charging at specific times. Fewer than one-fifth (14%) indicated they were signed up for PGE's Time of Use pricing.

Figure 19. Location EV Owners Typically Charge Their Vehicle (Multiple Responses Allowed)

EV owners who charge at home typically charge one to four days per week. About two-thirds (61%) of Wave 3 EV owners who charge at home report charging between one and four days per week, with about one-third (30%) indicating they charge at least daily (Figure 20). PHEV owners are more likely to charge daily—37% of PHEV-only owners charge at least once a day at one of the four locations asked, compared to EV-only owners who report daily charging (28%).

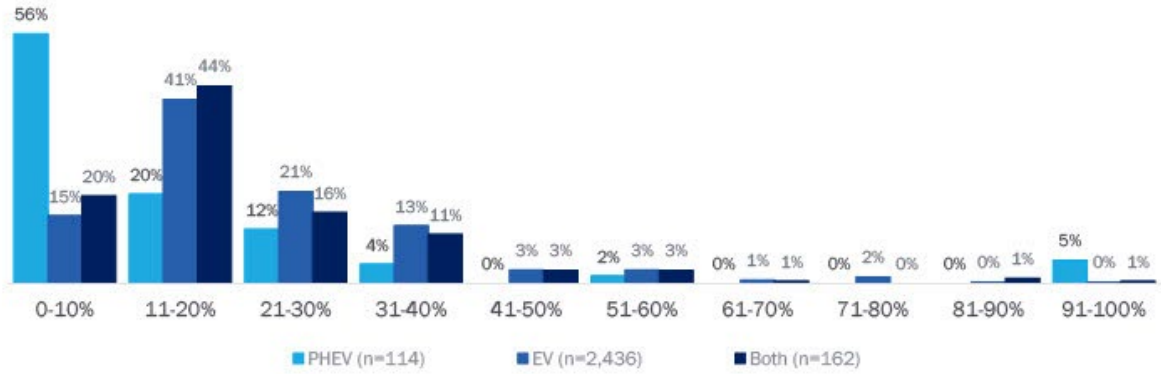
Figure 20. Frequency of Charging EV/PHEV at Stated Locations Used for Charging



Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). This question was asked only of respondents who reported charging their EV or PHEV at each location.

Most EV owners report that they typically charge their vehicle when the state of charge is 30% or below. Over one-half of PHEV owners (56%) reported they typically plug in their PHEV when it is 10% or below, as compared to EV owners who are more likely to charge when their battery is between 11% and 30% (62%; Figure 21).

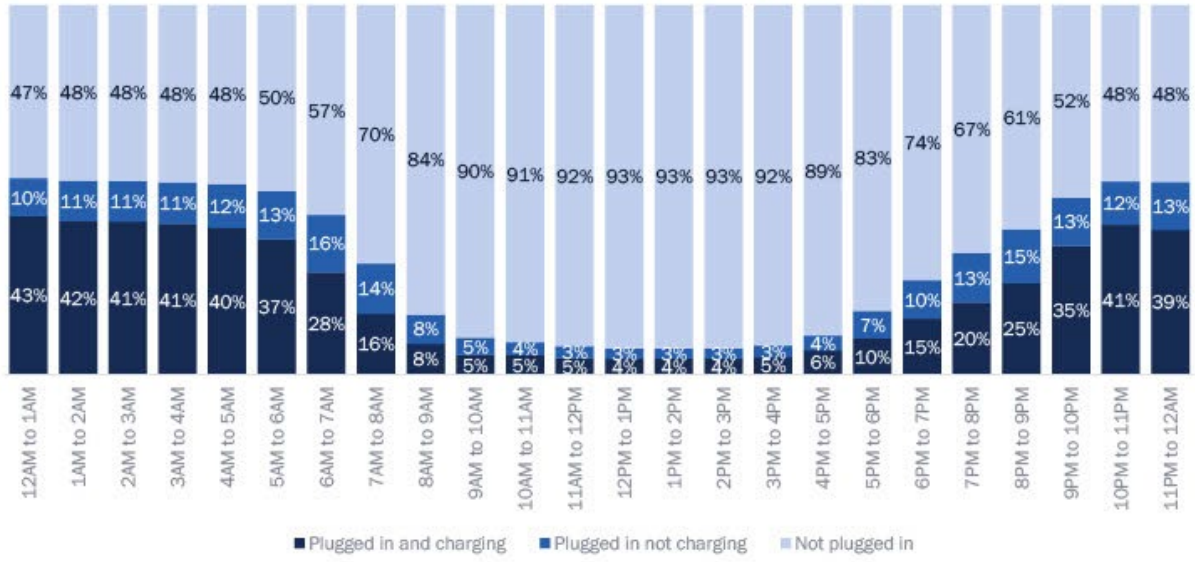
Figure 21. Battery Percentage Remaining When EV Owners Typically Start Charging (Wave 3 EV Owners Only)



Note: Question only asked in the Wave 3 survey.

Significantly more EV Owners in Wave 3 regularly set schedules on their home chargers (42% in Wave 3; up from 30% in Wave 2), with most of their active charging occurring between 9:00 p.m. and 6:00 a.m. Looking specifically at typical charging patterns, EV owners who charge at home were asked what hours their EV is plugged in, whether charging or not, and then asked what hours their EV is actively charging or programmed to charge. Figure 22 shows that about half of owners have their vehicles plugged in between 9:00 p.m. and 6:00 a.m., with the most common charging times between 10:00 p.m. and 6:00 a.m.

Figure 22. EV Charging Times (Wave 3 EV Owners Only; n=2,488)



Home charging is most important to potential owners, and its availability may factor into decisions to purchase or lease an EV or PHEV. Overall, about two-thirds (63%) of Wave 3 non-EV owners indicated that having charging available at home was most important to them (Figure 23). Charging along major highways was the most important location for charging outside of the home. A few respondents (8%) reported that other public charging locations were most important to them.

Figure 23. Most Important Location to Have Charging Available, by Survey Wave and Segment

Most Important Place to Have Charging	All Likely Vehicle Purchasers			Wave 3 - All Likely Vehicle Purchasers		
	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)
At home	73% D	70% D	63%	54%	63%	76% A B
Along major highways to support inter-city travel	N/A[a]	13% B	12% B	13%	13%	9%
At public locations (e.g., grocery stores, coffee shops, malls)	14% C D	8%	8%	7%	13% A C	7%
At work	7% C	4%	6% C	8% C	8% C	3%
Don't know	5%	6%	10% B C	18% B C	3%	5%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.
[a] Item not displayed to Wave 1 survey respondents.

EV owners are more likely to have a personal garage to park their vehicles compared to other segments. Three-quarters (75%) of EV owners reported parking their vehicle in their personal garage. In comparison, more than half of intenders park in a personal garage (57%) while fewer than half of non-considerers (44%) and considers (46%) do so (Figure 24).

Figure 24. Typical Parking Location at Home

Current Parking Options At Home	Wave 3 - All Likely Vehicle Purchasers/Owners				
	Wave 3 (n=934) (D)	EV/PHEV Non-Considerers (n=370) (A)	EV/PHEV Considerers (n=231) (B)	EV/PHEV Intenders (n=333) (C)	EV/PHEV Owners (n=2718) (D)
Driveway/carport	61%	60%	59%	63%	63%
Personal garage	49%	44%	46%	57% A B	75% A B C
On-street (free)	45%	45%	45%	45%	49%
Parking lot (reserved space)	12%	13% D	15% C D	8% D	2%
Parking lot (no reserved space)	8%	8% D	9% D	6% D	2%
Parking garage (private)	7%	9%	5%	6%	9% B C
On-street (permit/metered)	5%	4%	5%	6% D	3%
RV park/yard/field	2%	4% B C D	1%	1%	2%
Parking garage (public)	2%	1%	2%	1%	1%
None of these	0%	1%	0%	0%	0%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$).

Note: Question only asked in the Wave 3 survey.

Most EV owners have an electric service outlet available where they park their vehicles at home (92%). Access to an electric service outlet is lowest among non-considerers (23%) and increases as the purchase intent increases (Figure 25).

Figure 25. Availability of Electric Service Outlet Where Respondents Park at Home

Availability of Electric Service Outlet	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
Yes	29%	39% A	36% A	35% A	94% B	92%	23%	35% A	49% A B	92% A B C
No	58% B C	50%	52%	54%	5%	7% A	62% C D	57% C D	41% D	7%
Don't know	13%	11%	12%	12%	1%	1% A	16% B C D	8% D	10% D	1%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$).

When asked which of their at-home parking options also has an electrical outlet, most respondents cited their personal garage if they had an outlet. Almost three-fourths of EV owners have an electrical outlet in their garage, and two-fifths have access to an electrical outlet in their driveway or carport (Figure 26). Across all segments, non-EV owners who

have personal garages are much less likely to have electrical outlets in their garages compared to EV owners. Close to half of intenders and considers with garages would still need to have an outlet installed if they wanted to charge an EV at home in their garage.

Figure 26. Home Parking Location Options with Electrical Outlets, Wave 3 only by Segment

Current Parking Options At Home	Wave 3 - All Likely Vehicle Purchasers/Owners				
	Wave 3 (n=934) (D)	EV/PHEV Non-Considerers (n=370) (A)	EV/PHEV Considerers (n=231) (B)	EV/PHEV Intenders (n=333) (C)	EV/PHEV Owners (n=2718) (D)
Driveway/carport	61%	60%	59%	63%	63%
Personal garage	49%	44%	46%	57% A B	75% A B C
On-street (free)	45%	45%	45%	45%	49%
Parking lot (reserved space)	12%	13% D	15% C D	8% D	2%
Parking lot (no reserved space)	8%	8% D	9% D	6% D	2%
Parking garage (private)	7%	9%	5%	6%	9% B C
On-street (permit/metered)	5%	4%	5%	6% D	3%
RV park/yard/field	2%	4% B C D	1%	1%	2%
Parking garage (public)	2%	1%	2%	1%	1%
None of these	0%	1%	0%	0%	0%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$).

Few non-EV owners (15%) reported having charging access at their workplace in the Wave 3 survey, which is consistent with previous survey waves. Again, EV owners are more likely to report workplace charging access than the other segments (30%, compared to 21% of intenders, 16% of considerers, and 9% of non-considerers). Workplace charging does not appear to be a critical factor in customers' decisions to purchase an EV in the aggregate; most Wave 3 respondents reported that having workplace charging would have either no effect on their decision (41%) or make them somewhat more likely to purchase or lease an EV/PHEV (34% reporting). Interestingly, respondents who reported living in multifamily residences are more likely to report that having access to workplace charging would make them more likely to purchase or lease an EV, compared to respondents living in single family residences (63% vs. 49%, respectively).

4.4.4 EV KNOWLEDGE AND EXPERIENCE

UNDERSTANDING OF EV FUEL COSTS

Non-EV owners' understanding of the fuel costs associated with EVs/PHEVs relative to gasoline vehicles has improved steadily since the Wave 1 and Baseline surveys (68% in Wave 3, up from 21% in Baseline, 20% in Wave 1, and 58% in Wave 2) (Figure 27). Still, non-EV owners lag behind EV owners in their understanding of fuel costs. When asked whether respondents were aware that a typical EV or PHEV driver would spend approximately $1.50 for electricity instead of $4.30 for gasoline to drive the same distance, EV owners were significantly more likely to report being aware compared to all other segments, suggesting an opportunity for PGE to further increase customer understanding of the lower fuel costs associated with EVs/PHEVs.

Figure 27. Awareness that EV Fuel Costs are Typically Less than Gasoline Vehicles, by Survey Wave and Segment

Awareness that Fuel Costs are Lower for EVs	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
Yes	21%	20%	58% A B	68% A B C	96%	97%	58%	68% A	80% A B	97% A B C
No	79% C D	80% C D	42% D	32%	4%	3%	42% B C D	32% C D	20% D	3%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

IMPACT OF EV KNOWLEDGE ON LIKELIHOOD TO PURCHASE EVS

After learning about the low fuel costs associated with EVs (Figure 27), more than half of customers reported they would be much or somewhat more likely to consider EVs in the future, consistent with the previous waves (Figure 28). Non-considerers were significantly less likely to report a change in their likelihood of considering an EV compared to the other segments.

Figure 28. Impact on Likelihood to Purchase EVs After Learning about Lower Fuel Costs, by Survey Wave and Segment

Impact of EV/PHEV Fuel Cost Per Mile Advantage Over a Typical Gasoline Vehicle	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
Much or Somewhat more likely	58% D	54%	56% D	50%	72%	71%	27%	62% A	70% A	71% A B

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

Similarly, after being informed that there are about 232 publicly accessible DCFCs in Oregon that can charge most EVs to 80% in 30 to 60 minutes, about half (51%) of the non-EV owners indicated being "much" or "somewhat" more likely to consider an EV in the future (Figure 29). Again, non-considerers were significantly less likely to report a change in their likelihood to purchase an EV compared to the other segments.

Figure 29. Impact on Likelihood to Purchase EVs After Learning about Fast Charging Time, by Survey Wave and Segment

Likelihood to Consider EVs based on Availability of DC Fast Chargers	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
Much more or somewhat more likely to consider purchasing an EV/PHEV	38%	41% D	51% ABD	34%	69%	66% A	18%	43% A	48% AB	66% ABC

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

DRIVING EXPERIENCE

More customers report having personal experience driving an EV, which can be influential in purchasing decisions. About one-third (31%) of respondents mentioned they had experience with driving an EV, up from about one-quarter (26%) in Wave 2 (Figure 30). Among EV owners who test drove an EV before leasing or purchasing (86% of owners), nearly three-quarters (63%) reported they were at least moderately influenced by the test drive when deciding to lease or purchase their EV.[6] Without the test drive, one-third (17%) of these EV owners would have postponed purchasing an EV or purchased a different vehicle. In comparison, one-half (50%) would have made the exact same purchase, highlighting the importance of ride-and-drive events in customer purchasing decisions.

[6] Respondents who rated the level of influence as 6–7 on a 10-point scale, where 0 was "not at all influential" and 10 was "extremely influential," were categorized as "moderately influenced" and those who rated the level of influence as 8–10 were categorized as "greatly influenced."

Figure 30. Respondent Experience with Driving an EV, by Survey Wave and Segment (Multiple Responses Allowed)

Driven an EV/PHEV	All Likely Vehicle Purchasers			Wave 3 - All Likely Vehicle Purchasers		
	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)
Yes, a friend's, family member's, or colleague's	14%	19% B	21% B	16%	20% D	28% A B D
Yes, my own electric or plug-in hybrid vehicle	1%	1%	3% B C	0%	3% A	7% A B
Yes, at a dealership	3%	3%	5%	2%	4%	9% A B
Yes, at ride-and-drive event	2%	1%	3% C	1%	1%	5% A B D
No	80% C D	74% D	69%	77% C D	71% C D	58% D
Don't know	2%	2%	2%	4% C D	2%	1%

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

TNC AND ON-DEMAND DELIVERY DRIVERS

About 5% of the Wave 3 survey respondents indicated that they were either a TNC driver (49 respondents), an on-demand delivery driver (52 respondents), or both TNC and on-demand delivery (7 respondents). Of the 108 TNC and on-demand delivery drivers, about one-third (37%, or 40 respondents) reported owning an EV.[7] TNC and on-demand delivery drivers who reported owning an EV most commonly reported charging their vehicles at home (83%) and/or public charging stations (53%). Of those drivers who charge their vehicles at PGE's EAs (9 of 40), five reported having an unlimited monthly charging subscription, three indicated paying by the hour, while another one was unsure of their typical payment method used at PGE's EAs.

4.5 DRIVERS OF EV ADOPTION

This section provides survey findings on customer awareness, use of, and interest in PGE EV resources, including PGE's EAs, partner dealers, and information from PGE, in addition to the impact PGE EV resources have had on customer adoption of EVs. The section also details customer awareness, use of financial incentives for EVs, and customer opinions on PGE's role in transportation electrification.

[7] Note the survey included an oversample of EV owners, which is why there is a large proportion of EV owners among TNC and on-demand delivery drivers.

4.5.1 EV INFRASTRUCTURE, INFORMATION, AND SERVICES SUPPORTED BY PGE

PGE ELECTRIC AVENUES

Customer awareness of PGE's Electric Avenues continued to decrease, reaching the same level as the Baseline survey. Fewer than one-fifth (14%) of Wave 3 respondents reported seeing at least one EA (down from 25% in Wave 2 and 33% in Wave 1; Figure 31). Customers considering or intending to purchase an EV/PHEV are more likely to have seen an EA than non-considerers (15% and 18% vs. 10%). Further, one-third (31%) of EV owners report being aware of at least one EA location. Among EV owners who reported seeing an EA, about one-quarter (26%, down from 38% in Wave 2) reported using at least one EA location to charge their vehicle. EV owners who reported using at least one EA most commonly reported using the Eastport Plaza (30%) and the Hillsboro (29%) EAs for charging their EVs.

Figure 31. Awareness of PGE Electric Avenues

	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=828) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=957) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=404) (A)	EV/PHEV Considerers (n=233) (B)	EV/PHEV Intenders (n=320) (C)	EV/PHEV Owners (n=2718) (D)
Has seen PGE Electric Avenue	13%	33% ACD	25% AD	14%	38% B	31%	10%	15% A	18% A	31% ABC

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

The availability of PGE's EAs is moderately influential in respondents' decision to purchase or lease EVs. In a survey of EA users conducted by the research team in 2022, over half (57%) of respondents were aware of PGE's EAs prior to purchasing their EVs.[8] Among those who were aware of EAs prior to purchasing their EVs, about half (52%) indicated PGE's EAs were either somewhat or very influential in their decision to purchase or lease their vehicles (Figure 32).

Figure 32. Influence of Availability of EAs on Purchase Decisions Among Those Aware of EAs Prior to Purchase (n=90)

[8] Additional findings from research with EA users can be found in the 2022 Annual Report.

PGE PARTNER DEALERS

Few (12%) EV owners reported visiting a PGE partner dealer when purchasing their EV/PHEV. Partner Nissan and Chevrolet dealers were the most common partner dealers visited (Table 7). A majority (64%) of EV owners reported visiting a Tesla store when they purchased their EV/PHEV. EV owners who visited a partner dealer rated a partner used EV dealer as the most informative (an average rating of 9 on a 0–10 scale), likely because the dealer primarily sells used EVs and PHEVs.

Few (13%) EV owners reported being shown the educational kiosk while visiting a PGE partner dealer. Customers who visited partner Hyundai and Volkswagen dealers were most likely to report being shown the kiosk. Customers who were shown the educational kiosk reported finding the kiosk moderately helpful in understanding EV charger availability and EV charging times (providing an average rating of 7 on a 0 to 10 scale, where 0 was "not at all helpful" and 10 was "extremely helpful").

Table 7. Proportion of EV Owners Who Visited Partner Dealers, Rated Level of Informativeness of Dealer, and Proportion of EV Owners Shown the Educational Kiosk

Dealer	Visited (n=4747)[a]		Average Informative Score[b]	Shown the Educational Kiosk
	Count	Percent		
Partner Chevrolet dealer	173	2%	6	8%
Partner Nissan dealer	168	2%	7	18%
Partner Volkswagen dealer	109	1%	7	23%
Partner used EV dealer	58	1%	9	12%
Partner BMW dealer	54	1%	7	11%
Partner Audi dealer	39	<1%	7	18%
Partner Kia dealer	39	<1%	6	19%
Partner Hyundai dealer	35	<1%	6	26%
Partner Ford dealer	7	<1%	7	14%

[a] Results from the Wave 2 and Wave 3 EV owners were combined for this analysis due to low sample sizes.

[b] EV Owners were asked to rate each dealer on how informative they were when they purchased or leased their EV or PHEV using a scale from 0 to 10, with 0 meaning "not at all informative" and 10 meaning "very informative."

INFORMATION FROM PGE

Similar to Waves 1 and 2, about one-quarter (24%) of Wave 3 non-EV owners reported seeing at least one PGE EV-related resource or campaign (Figure 33). EV owners were more than twice as likely to report seeing at least one PGE EV resource than non-EV owners (53% vs. 24%). Non-EV owners were most familiar with emails, PGE's EA's, and PGE's website information on EVs, followed by PGE's $500 discount for installing a PGE-approved Level 2 charger through the Residential EV Smart Charging Pilot. EV owners were significantly more likely to be familiar with these top four PGE sources than non-EV owners.

Figure 33. PGE EV Resources, Campaigns, or Discounts Seen by Respondents, by Survey Wave and Segment (Multiple Responses Allowed)

PGE Resources Seen	All Likely Vehicle Purchasers			EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
Emails from PGE on electric vehicle services or charging	6%	5%	9% BC	11%	24% A	4%	15% A	11% A	24% ABC
Any PGE Electric Avenue location	8%	10% D	7%	18%	16%	4%	8%	9% A	16% ABC
PGE website information on electric vehicles	4%	4%	6%	11%	21% A	3%	7% A	8% A	21% ABC
PGE's $500 discount for purchasing and installing a PGE-approved Level 2 charger	1%	4% B	6% BC	9%	30% A	1%	7% A	11% A	30% ABC
Social media information from PGE on electric vehicles	2%	5% B	5% B	3%	4%	4%	5%	5%	4%
Electric Car Insider's Electric Car Guest Drive in Milwaukie	1%	0%	2% BC	1%	1% A	0%	3% A	3% A	1%
PGE's sponsored ride-and-drive events	2%	1%	2%	2%	4% A	2%	2%	2%	4% AB
PGE's Drive Change Fund	1%	1%	1%	0%	1%	1%	1%	1%	1%
Interactive Chargeway kiosks	1%	1%	1%	1%	1%	1%	1%	1%	1%
National Drive Electric Week advertising (in 2018 or 2019)	1%	0%	1%	3% B	2%	0%	0%	1%	2% AB
Chargeway App	0%	0%	0%	4% B	3%	0%	0%	1%	3% ABC
Didn't see any of these	63% D	61% D	56%	50% B	37%	59% D	54% D	52% D	37%
Don't know	17%	17%	20%	11%	10%	26% BCD	17% D	16% D	10%

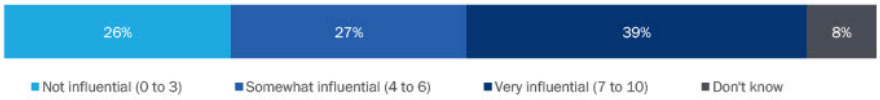
Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons. Question only asked of Wave 1 and Wave 2 survey respondents. PGE EA locations were asked individually but combined in this table.

[a] PGE's Beaverton, Wilsonville, and Salem Electric Avenue sites were not in operation at the time of the Wave 1 survey.

PGE's EV-related information, resources, and campaigns have been moderately influential in respondents' decision to purchase or lease EVs. Two-thirds (66%) of respondents indicated that information, resources, or campaigns at least moderately influenced their decision to purchase or lease an EV (Figure 34).

However, about two-thirds (72%) of EV owners who received information about EVs from PGE reported that they would have made the exact same purchase if they had not received any information from PGE.

Figure 34. Influence of PGE EV Resources, Campaigns, or Discounts on EV Purchase Decision (n=1798)



ADDITIONAL PGE INFRASTRUCTURE

Increasing charging access could have a positive impact on increasing EV adoption. About one-third (29%) of non-EV owners indicated that their current parking situation is a "major concern" in their decision to purchase an EV or PHEV in the future. Non-EV owners were asked how much influence infrastructure factors (such as increasing access to public charging or charging at multifamily residential locations) could have on their decision to purchase or lease an EV. Among those who mentioned their parking situation was a "major concern," over one-third (36%) reported that having access to public on-street pole charging in their neighborhood would increase their likelihood to consider an EV (Figure 35). Additionally, about half (52%) of multifamily respondents indicated that onsite parking with charging at their complex would increase their likelihood to consider an EV.

Figure 35. Likelihood to Consider EV based on Access to On-Street Charging and Onsite Multifamily Charging

(Non-Owners Only Who Indicated Parking is a Major Concern)

Likelihood to Consider EVs (% Highly Likely 8-10)	All Likely Vehicle Purchasers		Wave 3 - All Likely Vehicle Purchasers		
	Wave 2 (n=234) (C)	Wave 3 (n=222, 168) (D)	EV/PHEV Non-Considerers (n=104, 78) (A)	EV/PHEV Considerers (n=65, 52) (B)	EV/PHEV Intenders (n=53, 38) (C)
If you had access to public on-street charging (typically mounted to utility poles) in your neighborhood	35%	36%	19%	52% A	53% A
If onsite parking with charging was available at your multifamily complex [a]	N/A	52%	31%	68% A	78% A

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons. Figure includes results from non-owners who reported parking was a "major concern" in their decision to purchase an EV or PHEV.

[a] Excludes respondents who indicated they did not live in multifamily housing. Not asked in the Wave 2 survey.

4.5.2 FINANCIAL INCENTIVES

Awareness of any state or federal tax incentives to help offset the up-front costs of EVs has increased significantly. Over half (57%) of Wave 3 respondents were aware of state or federal EV tax incentives, compared to 47% of Baseline, 43% of Wave 1, and 44% of Wave 2 respondents (Figure 36). Non-considerers and considerers are significantly less likely to report being aware of tax incentives compared to intenders (47% and 57%, compared to 70%). Awareness of incentives is much higher among EV owners compared to non-owners (91% vs. 57%).

Figure 36. Awareness of State or Federal Tax Incentives by Survey Wave and Segment

	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=947) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
Aware of state or federal tax incentives	47%	43%	44%	57% A B C	94%	91%	47%	57%	70% A B	91% A B C

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

Most EV owners receive some form of financial incentive during the EV purchase process. A majority of Wave 2 (86%) and Wave 3 (78%) EV owners reported receiving a financial incentive, most commonly federal or state tax credits (Figure 37). Significantly fewer Wave 3 owners reported receiving federal tax and state tax credits compared to Wave 2 owners, likely because of the discontinuation of Oregon's state rebate and changes to eligibility requirements for the federal tax credit.

Figure 37. Sources of Financial Assistance Received by EV Owners During Purchase Process (Multiple responses allowed)

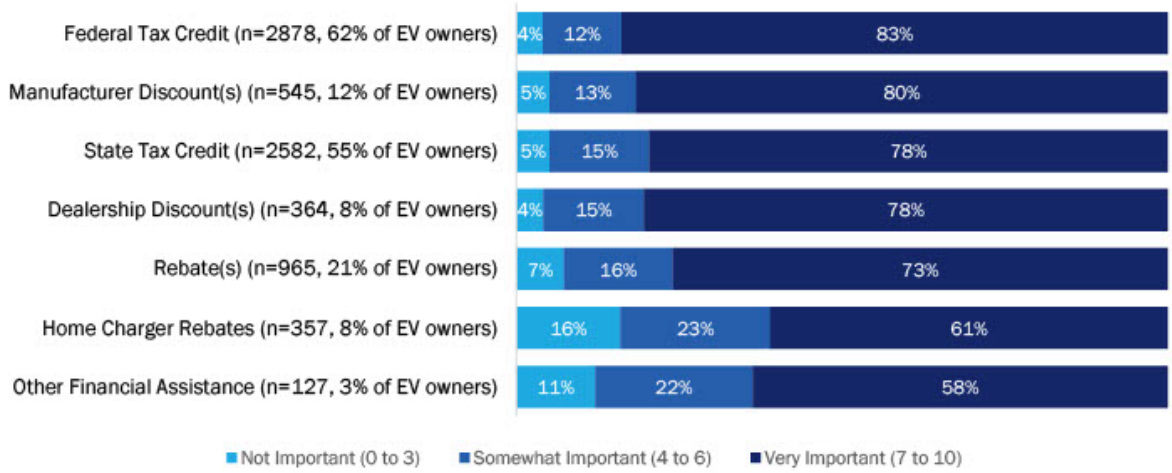
Sources of Financial Assistance	EV/PHEV Owners	
	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)
Federal Tax Credit	67% B	56%
State Tax Credit	59% B	52%
Rebate(s)	23% B	18%
Home charger rebates	N/A[a]	13%
Discount(s) from car manufacturer(s)	14% B	10%
Discount(s) from car dealership(s)	10% B	6%
Other	3%	2%
None of these	14%	22% A

Note: Letters indicate statistically significant differences between waves (z-test for proportions, $p < .05$).

[a] Item not displayed to Wave 2 survey respondents.

Financial incentives are an important part of the purchase decision process. The majority of Wave 3 respondents who received a federal tax credit rated it as very important (83%) (Figure 38). Of those who received a home charger rebate, slightly under two-thirds (61%) said it was very important.

Figure 38. Importance of Financial Incentive on Purchase Decision



4.6 PGE'S ROLE IN TRANSPORTATION ELECTRIFICATION

Customers are supportive of PGE's efforts to ensure convenient EV charging is available in the community. When asked about different roles that PGE could play to support EVs, respondents were most in agreement that PGE should invest to ensure that the existing electrical system supports convenient charging and should make installing a home EV charging station easier (Figure 39). Respondents were in less agreement about whether PGE should electrify its own vehicle fleet. Overall, customers in the non-considerer segment were less likely to agree with the statements about PGE's role in supporting EVs compared to the other segments.

Figure 39. Respondent Agreement with Statements About PGE's Role in Supporting EVs, by Survey Wave and Segment (Multiple Responses Allowed)

Agreement with Statements on Expectations with PGE	All Likely Vehicle Purchasers				EV/PHEV Owners		Wave 3 - All Likely Vehicle Purchasers/Owners			
	Baseline (n=0-929) (A)	Wave 1 (n=1026) (B)	Wave 2 (n=1179) (C)	Wave 3 (n=975) (D)	Wave 2 (n=1951) (A)	Wave 3 (n=2718) (B)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
I support the idea that PGE should be working and investing now to ensure that the existing electric system is able to support convenient recharging of electric cars and trucks	81%	80%	84% B D	80%	96%	95%	62%	91% A	94% A	95% A B
PGE should make installing a home electric vehicle charging station easier and more affordable	N/A*	N/A*	83%	79%	90%	89%	63%	88% A	93% A D	89% A
PGE should make owning an electric vehicle more convenient and feasible by installing and maintaining public charging stations	75%	77%	79% A	77%	89%	90%	59%	86% A	92% A B	90% A
PGE should make owning an electric vehicle more convenient and feasible by installing and maintaining multifamily charging stations	N/A*	N/A*	69%	73% C	79%	87% A	56%	81% A	89% A B	87% A B
PGE should take an active role in educating people about electric vehicles	75%	74%	77%	73%	89% B	85%	57%	82% A	87% A	85% A
I believe that PGE is a credible source of information about electric vehicles	73% D	74% D	75% D	67%	77%	76%	53%	77% A	77% A	76% A
PGE should convert its own vehicle fleet to electric power as soon as possible	67%	67%	72% A B D	64%	87% B	83%	40%	76% A	85% A B	83% A B

Note: Letters indicate statistically significant differences between survey waves and likely vehicle purchaser segments (z-test for proportions, $p < .05$). The statements "PGE should make installing a home electric vehicle charging station easier" and "PGE should make owning an electric vehicle more convenient and feasible by installing and maintaining multifamily charging stations" were added for Wave 2 and were not asked of Wave 1 and Baseline respondents. Respondents who rated the level of agreement as 6–10 on a 10-point scale, where 0 was "completely disagree" and 10 was "completely agree," were categorized as agreeing with the above statements.

* Item not displayed to Baseline or Wave 1 survey respondents.

4.7 EQUITY IMPACT

A key cross-cutting objective of the TE pilots is to increase access to electrified transportation for underserved communities, including those with disproportionately lower incomes, persons of color, seniors, renters, and low concentrations of charging infrastructure, herein referred to as "underserved communities."

As part of the 2020 Annual Report, the evaluation team analyzed the responses from Baseline and Wave 1 surveys with non-EV owners to establish a baseline on key pilot performance metrics that PGE could use to identify opportunities to serve underserved communities better. The findings compared four demographic sub-groups: low-income with non-low-income, seniors with non-seniors, White with non-White/people of color (POC), and renters with owners. In the following section, the evaluation team provides comparisons between the Baseline/Wave 1 surveys and Wave 3 survey for key survey questions. Table 8 summarizes the proportions of each demographic sub-group, by survey wave. The proportions of survey respondents in each demographic sub-group are similar in Wave 3 compared to the Baseline/Wave 1 surveys, except that the Wave 3 survey had a higher proportion of renters.

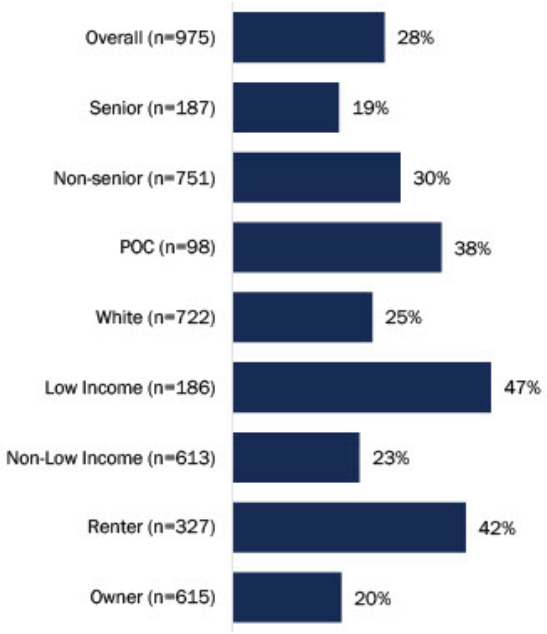
Table 8. Definitions of Key Customer Sub-Groups

Segment	Definition	Baseline / Wave 1		Wave 3	
		Count	Percent	Count	Percent
Low-income	Respondents who meet the Oregon Housing and Urban Development (HUD) low-income guidelines for the state of Oregon (80% percent of the area median household income level)	340	20%	186	19%
Seniors	Respondents aged 65 or older	180	22%	187	19%
POC	Respondents who indicated they were Hispanic/Latino (42% of POC group), Black or African American (9%), Asian (Japanese, Korean, Pacific Islander, etc.) (40%), or American Indian/Native American (8%)	233	14%	98	10%
Renters	Respondents who rent their home	470	25%	327	34%

Note: Respondent age was not asked on the baseline survey.

Respondents identifying as POC, low-income respondents, and renters experience greater transportation hardship than other demographic sub-groups. In the Wave 3 survey, respondents were presented with a series of items that gauged the level of transportation hardship they experienced (i.e., living in a high emissions area, ability to afford car payments, access to transportation, and proximity to grocery stores). Overall, about one-quarter (28%) of all Wave 3 respondents indicated experiencing at least some level of transportation-related hardship. Low-income respondents were most likely to indicate any transportation-related hardship (47%), followed by renters (42%) and those identifying as POC (38%).

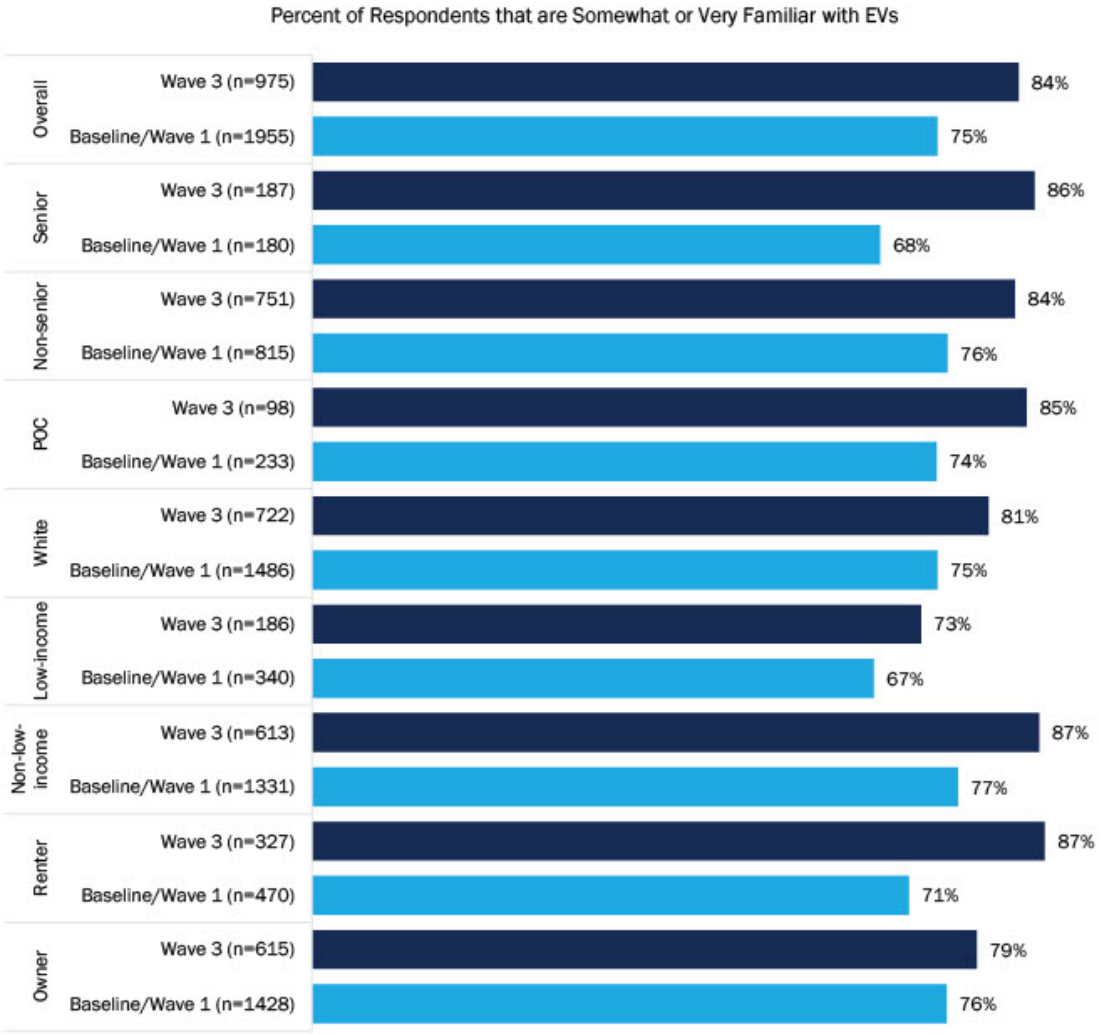
Figure 40. Percent of Respondents with High Transportation Hardship by Demographic Sub-group (Wave 3 Only)



Note: Question was not asked in Baseline or Wave 1 surveys.
EJ_1. Please indicate whether any of the following scenarios apply to your household. Please select all that apply. We live in an area that has high exposure to pollution from transportation (e.g., our home is near a major freeway, truck route, etc.); We have been unable to qualify to receive a car loan in the past five years; We rely on public transit as our primary form of transportation; The closest grocery store to our home is more than a ten-minute drive away; We spend approximately 25% or more of our monthly budget on transportation-related expenses, (e.g., gas, car repairs, insurance, public transit fares, and rideshare fees); My household has experienced challenges accessing transportation for essential needs (e.g., to get to work, the grocery story, medical appointments, etc.); None of the above scenario apply to my household.

Familiarity with EVs has increased significantly for each sub-group; however, low-income respondents continue to be less familiar than non-low-income respondents. About three-quarters (73%) of low-income respondents were very or somewhat familiar with EVs compared to 87% of non-low-income respondents (Figure 41). Low-income communities tend to have lower vehicle ownership rates than the general population, which may explain why these respondents consider themselves less familiar with EVs.

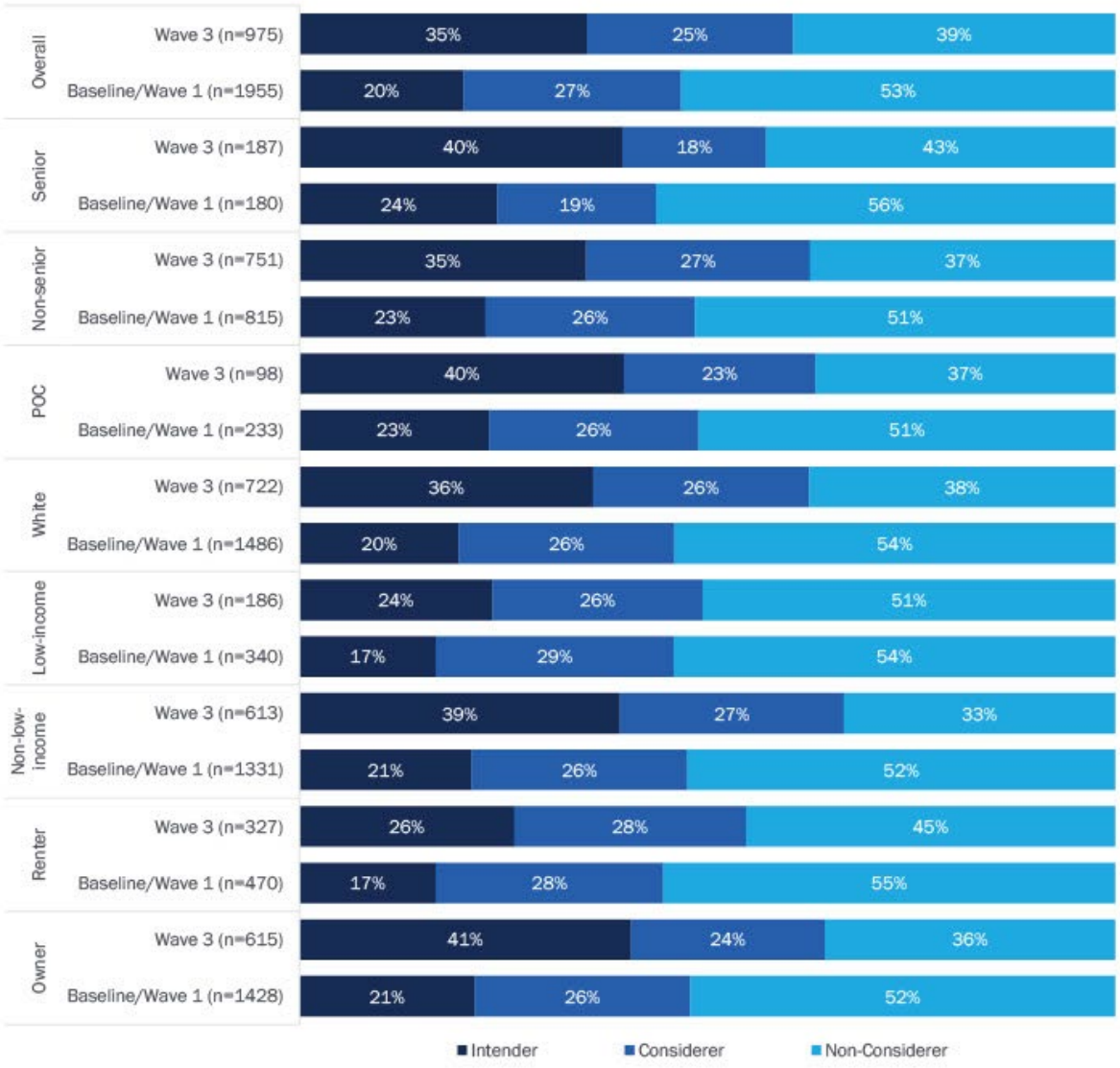
Figure 41. Familiarity with EVs by Demographic Sub-group and Survey Wave



Q1. In addition to vehicles using traditional gasoline internal combustion engines, some automobile manufacturers offer vehicles with powertrains that use other fuel types, including diesel, biodiesel, natural gas, and electricity. Please indicate how familiar you are with EVs.

Low-income respondents and renters are significantly less likely to report intending to purchase an EV compared to other demographic sub-groups, likely because of lower familiarity with EVs. There has been a marked increase in intention to purchase an EV between the Baseline/Wave 1 surveys and Wave 3 for all demographic sub-groups except for low-income respondents and renters (Figure 42). About one-quarter of Wave 3 low-income respondents (24%) and renters (26%) reported they intend to purchase an EV compared to 17% of each group in the Baseline/Wave 1 surveys. In contrast, nearly two-fifths of Wave 3 non-low-income respondents (39%) and homeowners (41%) reported that they intend to purchase an EV compared to 21% of their Baseline/Wave 1 counterparts.

Figure 42. EV Purchase Segments by Demographic Sub-group and Survey Wave



Underserved community members who intend to or are considering buying an EV are more likely to be motivated by many of the benefits of EV ownership than the general population. Wave 3 respondents who identify as POC, low-income respondents, and renters all tended to be more likely to identify lower fuel cost, the convenience of charging at home and work, and the availability of priority parking as major reasons to consider an EV in comparison to their demographic counterpart (e.g., whites, non-low-income, etc.) (Table 9). Seniors were considerably less likely to identify lower fuel cost as a major reason for considering an EV compared to non-seniors.

Table 9. Differences in How Demographic Sub-groups Identify EV Benefits vs. Their Counterparts (Wave 3 Only) [a,b]

Reason for Purchasing or Leasing an EV/PHEV (% Reporting a Major Reason)	Overall (n=590)	Senior (n=107)	POC (n=62)	Low-income (n=92)	Renter (n=179)
Protecting the environment	79%	82% (3%)	79% (-4%)	77% (1%)	81% (5%)
Lower fuel cost	77%	64% (-17%)	84% (8%)	84% (6%)	81% (6%)
Vehicle safety	77%	77% (0%)	76% (-1%)	78% (1%)	73% (-5%)
Less vehicle maintenance required	60%	63% (3%)	63% (4%)	54% (-8%)	60% (0%)
The convenience of charging my vehicle at home	52%	52% (-1%)	61% (11%)	54% (3%)	54% (2%)
Vehicle's performance and handling	51%	60% (10%)	53% (2%)	50% (0%)	45% (-9%)
Tax incentives and rebates	48%	55% (9%)	52% (6%)	43% (-5%)	48% (1%)
Availability of public charging stations in the Portland/Salem metro areas	38%	39% (0%)	42% (5%)	39% (1%)	36% (-3%)
Availability of public charging stations outside the Portland/Salem metro areas	32%	32% (0%)	48% (19%)	32% (2%)	38% (8%)
Number of miles vehicle will go on a single charge	31%	36% (6%)	37% (7%)	25% (-6%)	31% (0%)
The convenience of charging my vehicle at work	19%	8% (-14%)	26% (8%)	23% (5%)	28% (13%)
Priority parking at some locations	8%	2% (-8%)	18% (12%)	12% (5%)	15% (10%)
How I look driving and owning this vehicle	7%	4% (-4%)	15% (9%)	11% (4%)	11% (5%)

Greater than 6% more likely to consider benefit than non-target group
3% to 6% more likely to consider benefit than non-target group
3% to 6% less likely to consider benefit than non-target group
Greater than 6% less likely to consider benefit than non-target group

Q17. For each of the factors below, please indicate whether that factor is a major reason, a minor reason, or not a reason you are considering an all-EV/PHEV for your next purchase/lease.

Note: Differentials in percentages between each demographic sub-group (low-income and non-low-income respondents, renters and owners, etc.) are shown in parentheses.

[a] This question was only asked of respondents in the EV/PHEV Considerer and Intender segments.

[b] Numbers in parentheses indicate percentage differences for seniors compared to non-seniors, POC compared to white respondents, Low-income compared to non-low-income respondents, and renters vs. owners.

Underserved community members who do not own an EV were more likely to categorize certain characteristics of EVs as "major concerns," indicating that these groups face some unique barriers to adoption (Table 10). Wave 3 non-EV owners who identified as low-income, POC, and renters were more likely to indicate vehicle safety, maintenance costs, cost of charging the vehicle, availability of charging stations in the Portland/Salem metro area, concerns about power outages, and availability to charge at work as major concerns when thinking about whether to purchase or lease an EV.

Additionally, respondents who identified as POC showed higher levels of concern about aspects of EV technology, including the vehicle's performance and handling and availability of body types and sizes. These results suggest that customers who are renters, low-income, or POC know less about the advantages of owning an EV and would benefit from additional support connecting to sources of financing and funding for EVs. Customers from these communities would also likely benefit from continued access to programs that allow them to share in the benefits of transportation electrification without investing in a vehicle. Seniors generally had less concern about cost aspects related to EVs, including the purchase price of EVs, maintenance, and charging, but were more concerned about vehicle range and charging availability compared to non-seniors.

Table 10. Differences in EV Purchase Barriers by Demographic Sub-Groups vs Their Counterparts (Wave 3 only)[a]

Barriers to Purchasing or Leasing an EV/PHEV (% Reporting a Major Concern)	Overall (n=975)	Senior (n=187)	POC (n=98)	Low-income (n=186)	Renter (n=327)
Purchase price of vehicle	85%	78% (-8%)	86% (1%)	86% (5%)	85% (6%)
Number of miles vehicle will go on a single charge	77%	83% (8%)	72% (-6%)	72% (-6%)	75% (-5%)
Vehicle reliability	72%	67% (-6%)	69% (-3%)	72% (2%)	74% (2%)
Amount of time required to charge battery	64%	65% (1%)	63% (1%)	59% (-4%)	64% (1%)
Ability to charge at home	62%	58% (-4%)	63% (4%)	66% (1%)	62% (12%)
Vehicle safety	61%	56% (-6%)	65% (5%)	63% (6%)	65% (6%)
Maintenance costs	60%	49% (-14%)	67% (8%)	74% (18%)	70% (15%)
Availability of public charging stations outside of the Portland/Salem metro areas	58%	68% (12%)	63% (6%)	55% (-2%)	56% (-5%)
Concerns about cost to upgrade electrical panel to install home charger	51%	48% (-4%)	50% (-2%)	57% (8%)	56% (7%)
Vehicle's performance and handling	49%	47% (-2%)	61% (15%)	47% (-1%)	50% (2%)
Cost of charging the vehicle	48%	42% (-7%)	62% (17%)	58% (13%)	56% (12%)
Availability of public charging stations in the Portland/Salem metro areas	48%	52% (6%)	61% (15%)	53% (9%)	55% (10%)
Cost of installing home charging station	46%	44% (-2%)	48% (3%)	54% (11%)	53% (11%)
Environmental concerns about electric vehicle production	40%	40% (1%)	44% (6%)	46% (11%)	40% (-1%)
Concerns about electric power outages at my home	35%	34% (-1%)	43% (10%)	39% (6%)	37% (4%)
Electric vehicle body types and sizes available	33%	25% (-9%)	39% (7%)	29% (-5%)	27% (-9%)
Ability to charge at work	26%	12% (-17%)	42% (19%)	31% (7%)	34% (13%)

Greater than 6% more likely to consider barrier than non-target group
3% to 6% more likely to consider barrier than non-target group
3% to 6% less likely to consider barrier than non-target group
Greater than 6% less likely to consider barrier than non-target group

Q19. For each item, please indicate whether the issue described is a major concern, a minor concern, or not a concern to you at all when considering whether or not to purchase or lease an EV.

[a] Numbers in parentheses indicate percentage differences for seniors compared to non-seniors, POC compared to white respondents, low-income compared to non-low-income respondents, and renters vs. owners.

4.8 KEY DEMOGRAPHIC COMPARISONS

This section provides a profile of the customers who responded to the survey, including education, housing tenure, housing type, income, and gender.

Homeownership rates are significantly higher among EV owners than non-EV owners. Nearly all (93%) EV owners are homeowners compared to three-fifths (60%) of non-EV owners (Figure 43). EV intenders are more likely to own their homes than EV considerers and non-considerers (71% vs. 55% and 53%, respectively).

Figure 43. Respondent Housing Ownership Overall and by Segment

Home Ownership	Wave 3 - All Likely Vehicle Purchasers/Owners				
	Wave 3 (n=957)	EV/PHEV Non-Considerers (n=440) (A)	EV/PHEV Considerers (n=233) (B)	EV/PHEV Intenders (n=320) (C)	EV/PHEV Owners (n=2718) (D)
Own	60%	53%	55%	71% AB	93% ABC
Rent	37%	41% CD	43% CD	27% D	5%
Other	1%	2% D	1%	0%	0%
Prefer not to say	2%	3% D	1%	2%	1%

Note: Letters indicate statistically significant differences between segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

EV owners are more likely to live in single-family housing than non-EV owners. The majority (88%) of EV owners reported living in one-family detached housing compared to about two-thirds (63%) of non-EV owners (Figure 44).

Figure 44. Respondent Housing Type Overall and by Segment

Type of home	Wave 3 - All Likely Vehicle Purchasers/Owners				
	Wave 3 (n=975)	EV/PHEV Non-Considerers (n=385) (A)	EV/PHEV Considerers (n=246) (B)	EV/PHEV Intenders (n=344) (C)	EV/PHEV Owners (n=2718) (D)
One-family detached house	63%	58%	57%	72%	88%
One-family attached home	7%	7%	7%	7%	6%
A building with 2 to 4 apartments	7%	7%	9%	6%	1%
A building with 5 to 19 apartments	8%	10%	12%	4%	1%
A building with 20 to 49 apartments	4%	4%	3%	4%	1%
A building with 50 or more apartments	8%	10%	9%	5%	2%
Mobile home or trailer	2%	3%	2%	1%	0%
Other	1%	1%	0%	1%	0%

Notes: This question was asked with new answer choices in Wave 3 and is being reported separately.
Letters indicate statistically significant differences between segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

EV owners have higher levels of education than non-EV owners. About half (47%) of EV owners reported having a graduate or professional degree compared to slightly over one-fifth (22%) of non-EV owners (Figure 45).

Figure 45. Respondent Education Level Overall and by Segment

Education Level Attained	Wave 3 - All Likely Vehicle Purchasers/Owners				
	Wave 3 (n=957)	EV/PHEV Non-Considerers (n=440) (A)	EV/PHEV Considerers (n=233) (B)	EV/PHEV Intenders (n=320) (C)	EV/PHEV Owners (n=2718) (D)
Elementary school	0%	0%	0%	0%	0%
Some high school	1%	1% D	0%	1%	0%
Graduated high school	8%	11% C D	9% D	4%	2%
Trade or technical school	4%	5% D	3%	3%	2%
Some college	22%	26% B D	17% D	20% D	9%
Graduated college	40%	36%	45%	43%	38%
Graduate/professional school	22%	17%	24%	28% A	47% A B C
Prefer not to say	2%	3%	2%	1%	2%

Note: Letters indicate statistically significant differences between segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

EV owners have higher incomes than non-EV owners. Slightly under two-thirds (63%) of EV owners reported annual household incomes over $100,000 compared to slightly over one-quarter (28%) of non-EV owners (Figure 46).

Figure 46. Respondent Household Income Overall and by Segment

Household Income	Wave 3 - All Likely Vehicle Purchasers/Owners				
	Wave 3 (n=957)	EV/PHEV Non-Considerers (n=440) (A)	EV/PHEV Considerers (n=233) (B)	EV/PHEV Intenders (n=320) (C)	EV/PHEV Owners (n=2718) (D)
Less than $50K	24%	30% C D	25% C D	15% D	4%
$50K to less than $75K	16%	13% D	20% D	16% D	6%
$75K to less than $100K	13%	13% D	13% D	13% D	8%
Over $100K	28%	21%	29%	36% A	63% A B C
Prefer to not say	19%	22%	13%	20%	19%

Note: Letters indicate statistically significant differences between segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

EV owners are more likely to identify as male than non-EV owners (Figure 47). About three-fifths (59%) of EV owners identified as male compared to about two-fifths (37%) of non-EV owners.

Figure 47. Respondent Gender Overall and by Segment

Respondent Sex	Wave 3 - All Likely Vehicle Purchasers/Owners				
	Wave 3 (n=957)	EV/PHEV Non-Considerers (n=440) (A)	EV/PHEV Considerers (n=233) (B)	EV/PHEV Intenders (n=320) (C)	EV/PHEV Owners (n=2718) (D)
Male	37%	30%	38%	45% A	59% A B C
Female	55%	61% C D	56% D	48% D	35%
Other	1%	1%	1%	3% D	0%
Prefer to not say	6%	8% D	5%	5%	5%

Note: Letters indicate statistically significant differences between segments (z-test for proportions, $p < .05$). EV owners are excluded from overall survey wave comparisons.

APPENDIX A GENERAL POPULATION RESIDENTIAL CUSTOMER SURVEY DETAILED METHODOLOGY

This section describes the general population residential customer survey methodology. The team followed the methodology used for Baseline, Wave 1, and Wave 2 surveys to ensure comparability of results.

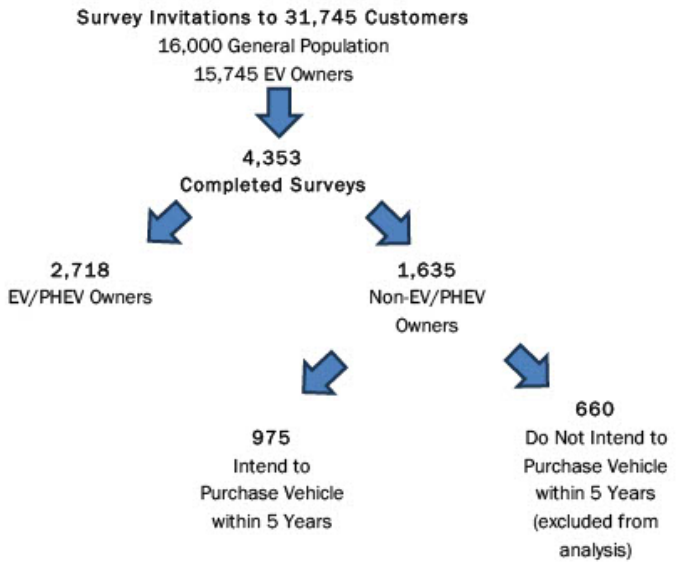
SURVEY SAMPLING FIELDING

PGE provided the team with a random sample of 16,000 residential customers and 15,745 EV owners with an email address on record. The team assumed a 5% response rate based on the response rate from the previous surveys. The team invited all 16,000 residential customers and 15,745 EV owners to take the survey via email invitation on August 22, 2023. To mitigate response bias, the team used neutral language in the invitation and did not specifically mention the survey topic, EVs. The invitation informed respondents that upon completion of the survey, they would be entered into a drawing for one of 12 gift cards (two valued at $500 and ten valued at $100). The team sent two reminder emails to non-responders and closed the survey on September 12, 2023. A total of 1,605 residential customers and 2,748 EV owners completed the Wave 3 survey with a 10% and 17% response rate, respectively, for a total of 4,353 completes.

The survey included a series of screening questions at the beginning. Respondents who reported being under the age of 18, those who may have a conflict of interest (employed in the environmental, marketing, media, utility, or automotive industry), those not involved in the decision-making for purchasing a vehicle, and those who were not planning to purchase a vehicle in the next five years were asked to supply demographic information and exit from the survey. The team reviewed survey responses and removed any surveys with a survey duration significantly below the average survey duration time or had responses that suggested the respondent was not engaged with the survey. The team also removed respondents who were a part of the EV owner sample and reported that they did not own an EV in the survey. This process resulted in a final completed count of 3,693 completed surveys.

Of the 3,693 respondents, 2,718 customers (74% of all respondents) reported owning or leasing an EV or PHEV. Among non-owners, 975 customers (61%) indicated they would likely purchase a vehicle within the next five years (Figure 48). The remaining 660 non-owners (15% of all respondents) reported that they do not intend to purchase a vehicle within the next five years, so they were excluded from the analysis.

Figure 48. Survey Respondents' Intent to Purchase any Vehicle within Five Years



WEIGHTING

Survey results of likely vehicle purchasers are weighted to correct for sampling and non-response bias present in the survey data. Specifically, the team used "raked weights" to adjust the sample to reflect known population proportions of age, income, county, and PGE residential segment. Population estimates of age and income are based on Acxiom data, and county and segment are based on PGE records. Sample estimates of age and income are based on survey responses. County and segment were appended from PGE records to each respondent.

Prior to calculating the raked weights, the team imputed age and income of any interested EV buyers who refused to provide their age or income in the survey. The team used the overall sample distributions of income and age to establish the proportional random assignment imputation algorithms for cases missing age or income. Similarly, for those interested EV buyers who did not have a PGE residential segment listed (n=134), the team used the overall sample distributions of residential segments to establish the proportional random assignment imputation algorithms for cases with missing segments.

These imputations resulted in the requisite survey data to execute the raked weighting procedure for all respondents without altering the sample's age and income distribution. The team then calculated and assigned raked weights to all surveyed likely vehicle purchasers; resulting raked weight values were not allowed to exceed 3.0. All likely vehicle purchaser results presented in this report are weighted.

APPENDIX B GENERAL POPULATION RESIDENTIAL CUSTOMER AND EV OWNER SURVEY INSTRUMENT

PGE TE Wave 3
General Population ar

Opinion **Dynamics**

Contact:

Zac Hathaway
Principal Consultant
zhathaway@opiniondynamics.com

BOSTON
PORTLAND
SAN DIEGO
SAN FRANCISCO

All product or company names that may be mentioned in this publication are tradenames, trademarks or registered trademarks of their respective owners.

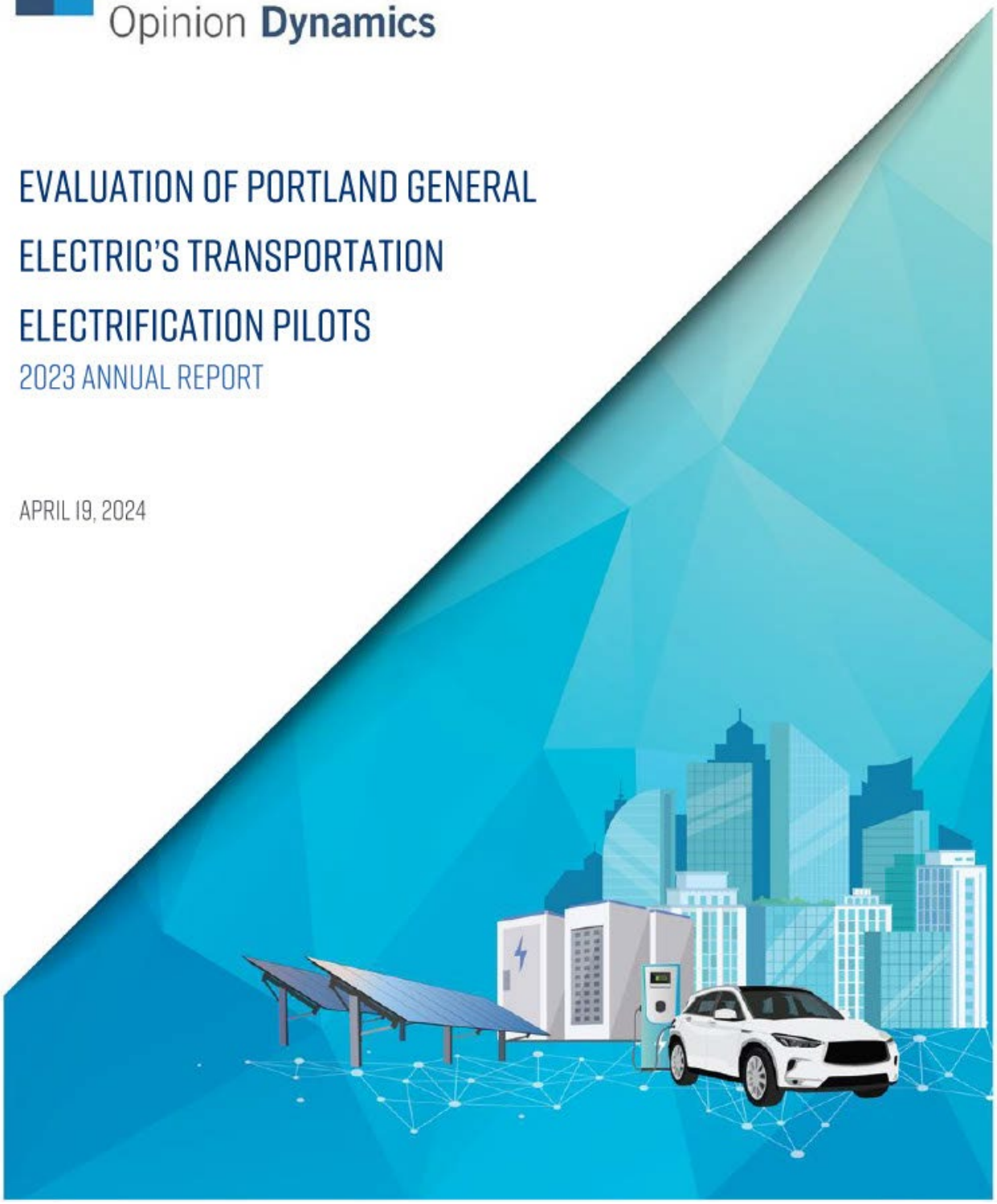
PGE

Opinion Dynamics

EVALUATION OF PORTLAND GENERAL ELECTRIC'S TRANSPORTATION ELECTRIFICATION PILOTS

2023 ANNUAL REPORT

APRIL 19, 2024



PGE

CONTENTS

TABLES & FIGURES

APPENDICES

I. EXECUTIVE SUMMARY

I.I PILOT SUMMARY AND EVALUATION ACTIVITIES

PGE has been working towards promoting greater electrification of the transportation sector by developing and implementing a wide range of programs. These programs are designed to cater to the needs of residential customers (single and multifamily), private and public fleet operators, municipalities, and businesses. Building from learnings from previous transportation electrification (TE) pilot programs, PGE launched three new pilots starting in 2020: Residential Electric Vehicle (EV) Smart Charging (Residential Charging Pilot), Business EV Charging Rebates (Business Charging Rebates Pilot), and the Fleet Partner Pilot. The following table summarizes each pilot's primary objectives and evaluation activities conducted by Opinion Dynamics ("the team"). This evaluation report covers pilot activities running from each pilot's inception through the second quarter of 2023. Results are reported for evaluation activities conducted between April 2023 to October 2023.

In the 2024 Annual Report, the team will provide evaluation results of Residential Charging Pilot activities conducted during the Summer 2023 and the Winter 2023/2024 event seasons. For the Business Charging Rebates Pilot and Fleet Partner Pilot, the 2024 report will cover pilot activities conducted from the third quarter of 2023 through the second quarter of 2024.

Table 1. Overview of Transportation Electrification Pilots

Pilot	Pilot Objective	Pilot Launch	Evaluation Activities
Residential Charging Pilot	Shift EV charging away from times of high system energy demand or when energy prices are highest. In exchange for rebates for Level 2 electric vehicle supply equipment (EVSE/chargers) and/or a credit on their electric bill, pilot participants allow PGE to control their EV charging during defined event hours. The pilot stops charging during these event hours on every non-holiday, weekday of each season. The winter season runs from October to March and the summer season from April to September.	2020; first event season in October 2021	▪ Interviews with PGE staff and implementation partners. ▪ Post-event survey with Winter 2022/2023 Event Season participants. ▪ Winter 2021/2022, Summer 2022, and Winter 2022/2023 Event Season impact and charging pattern analysis.
Business Charging Rebates Pilot	Accelerate EV adoption by ensuring adequate charging infrastructure is available to meet commercial customers' charging needs, reduce the cost and complexity of installing EVSE, and create a network of demand response (DR) enabled EVSE that can support efficient grid operations and future integration of renewables. The pilot provides tiered rebates for Level 2 EVSE and, up until April 2023, rebates for make-ready installations and DC Fast Chargers (DCFC).	2020	▪ Interviews with PGE staff. ▪ Interviews with participants who received rebates through the pilot. ▪ Charging pattern analysis.
Fleet Partner Pilot	Reduce costs and complexities for managers of nonresidential fleets who are interested in transitioning to electric fuel and creating a network of DR-enabled EVSE that can support efficient grid operations and future renewables integration. The pilot includes a Plan phase, which includes a fleet assessment and electrification plan, and a Build phase, which includes designing and constructing PGE-owned make-ready infrastructure.	2021	▪ Interviews with PGE staff and implementation partners. ▪ Interviews with fleet managers who applied but withdrew their application from the pilot. ▪ Online surveys with fleet managers who completed the Plan phase of the pilot. ▪ Interviews with those who completed the Build phase of the pilot. ▪ Charging pattern analysis

1.2 KEY FINDINGS AND RECOMMENDATIONS

The following section provides key evaluation findings and recommendations by pilot. Evaluation activities will continue through 2024, which will allow the team to monitor and expand on these findings.

1.2.1 RESIDENTIAL CHARGING PILOT

Pilot Participation Trends: Residential Charging Pilot enrollment has been strong, and the pilot has the opportunity to meet enrollment targets. However, to do so, the pilot may need to expand efforts to attract more EVSE participants. During the Winter 2022/2023 Event Season, 2,717 participants were enrolled in the pilot across the EVSE and evPulse channels. This is nearly double the number of participants from the Summer 2022 season and a 150% increase from the pilot's first season (Winter 2021/2022). Annual cumulative enrollment fell short of the 2022 target for unique chargers/vehicles but exceeded the target for 2023. Enrollment in the evPulse channel has driven growth in the pilot between the Summer 2022 and Winter 2022/2023 Event Seasons, exhibiting a 179% increase compared to a 52% increase in the EVSE channel. Nearly all EVSE participants received a standard charger rebate, with few receiving a Bring Your Own Charger (BYOC) rebate.[1] Results from a 2023 survey with EV Owners in PGE's service area show that about two-thirds of EV owners are not aware of the Residential Charging Pilot.[2] Residential Charging Pilot enrollment levels by event season and year are detailed in Section 3.1.

- **Recommendation:** Continue to increase EVSE enrollment in the pilot using targeted marketing to existing EV owners who are not enrolled in the pilot and may be eligible because they have a charger on the qualified products list (QPL). As of September 2023, a majority of EV owners in PGE's service area were not aware of the Pilot and may be eligible to participate.

Pilot Awareness and Marketing: Residential Charging Pilot Participant feedback suggests that current marketing priorities are well-aligned with customer preferences. Nearly three-quarters of participants report learning about the pilot through the PGE website or emails from PGE, which is the primary way the pilot is marketed. Participants report their primary motivation to participate was the rebate they received for their charger, but also report being motivated by the environmental benefits of participation and the seasonal charging incentives.

- **Recommendation:** Continue to rely upon the PGE website and email outreach to drive Pilot participation, as this has been an effective approach. Future marketing should continue to highlight the various benefits of the pilot, emphasizing charger rebates. PGE should also consider additional ways to publicize available tax credits for purchasing and installing charging.

Pilot Satisfaction and Participation Requirements: Residential Charging Pilot participants in both the EVSE and evPulse channels had a generally positive experience and were satisfied with their participation. However, a small percentage of participants (5% or less) faced challenges during the enrollment process. Areas of dissatisfaction noted by participants included the lengthy application process, the complexity of installing charging, difficulty finding a contractor, and delayed or non-response from pilot staff when reaching out with questions. Additionally, approximately one-third of EVSE participants and one-half of evPulse participants were unable to accurately identify the seasonal incentive requirements as part of the post event survey. Among participants who did not qualify for a seasonal incentive, about one-quarter indicated that the email informing them they did not qualify for the incentive did not make it clear what they needed to do differently to qualify in future seasons. Section 3.3 provides further detail and discussion around Pilot satisfaction and participation processes.

[1] BYOC rebates of $50 are available upon enrollment in the Residential Charging Pilot if a customer purchased and installed an eligible charger before the charger was added to the QPL. As such, BYOC participation is expected to decline as more chargers are added to the QPL.
[2] Survey results will be included in the upcoming UM1811 2023 Annual Report.

- **Recommendation 1:** Look for ways to streamline the application process to limit customer burden,[3] and ensure customer questions are responded to in a timely manner.
- **Recommendation 2:** Ensure customers have access to a list of qualified contractors they can reference when installing chargers,[4] and that contractors on the list receive details about the Residential Charging Pilot so they can ensure charger installations meet program requirements (i.e., the charger is on the Qualified Product List, the charger is hardwired, etc.).
- **Recommendation 3:** Consider additional targeted outreach to Pilot participants who continually do not receive seasonal incentives to inform them about the requirements and encourage participation.

Load Management Impacts: For the EVSE channel, the pilot achieved an average per charger demand impact of 0.37 kW during the Winter 2021/2022 Event Season, 0.40 kW during the Summer 2022 Event Season, and 0.49 kW during the Winter 2022/2023 Event Season, exceeding the 0.45 kW planning assumption for the third season.

The absolute level of charging load reduction is driven by the amount of baseline load available to shift and not customer behavior. Treatment Group C had consistently higher per charger load reduction than Group B. Across the three seasons, the average per charger load reduction was 0.54 kW for Group C and 0.29 kW for Group B. The difference is mainly due to the larger amount of baseline load available to shift during the Group C event window. The baseline charging load during the Group C window of 10 p.m. – 11:59 p.m. was 0.71 kW compared to 0.38 kW during the Group B window of 5 p.m. – 8 p.m. The amount of load reduction relative to the baseline was similar for the two treatment groups (an average of 76% for Group C and 78% for Group B across the three event seasons) suggesting that charging interventions are equally successful throughout the evening.

Group C's higher absolute load reduction is also due to Time of Day (TOD) enrollees being assigned to Group C. The baseline charging load of TOD enrollees was nearly double that of non-TOD pilot participants during the Group C window (1.06 kW compared to 0.58 kW during the Winter 2022/2023 Event Season). TOD enrollees in the control group, which provided the estimates of baseline load, shifted their charging to late-night hours, overlapping the Group C event window, whereas non-TOD control group members conducted more of their charging during early to mid-evening hours.

- **Recommendation:** For the EVSE channel, consider using the unmanaged charging patterns of Group A, the control group, to set planning assumptions for achievable load shifting for different event windows and for customers who are on the TOD rate. Based on the evaluation team's analysis of the first three event seasons, we make the following recommendations for the per charger planning assumption of each treatment group.

Table 2. Recommended Load Reduction Planning Assumptions for the Residential Charging Pilot EVSE Channel

Treatment Group	kW Load Reduction Per Charger Planning Assumption
B (5:00 p.m. – 8:00 p.m.)	0.30
C TOD (10:00 p.m. – 11:59 p.m.)	0.75
C Non-TOD (10:00 p.m. – 11:59 p.m.)	0.40

- The per charger planning assumption for the overall pilot should be a weighted average based on the number of enrollees per treatment group.

Load Impact Variability: Across the three event seasons, we observed growth in the amount of curtailable charging load and seasonal variation in the percent load reduction relative to baseline load. The baseline charging load of the Winter 2022/2023 season was 32% higher than the previous two seasons). As a result, the pilot exceeded its planning

[3] In mid-2023, PGE launched a new one-stop shopping platform called PGE+ to help customers find the right electrical equipment, get it installed, access instant rebates, and enroll in energy-shifting programs for ongoing rewards. The first offering is Level 2 EV chargers. The new application process for the Residential Charging Pilot through PGE+ will be assessed as part of the next evaluation cycle.

[4] Pilot staff launched an installer network in mid-2023 that provides a list of qualified contractors for potential Pilot enrollees to choose from.

assumption for kW load reduction for the first time (0.49 kW relative to 0.45 kW). Both treatment groups had higher percent load reduction relative to baseline load during the Summer 2022 Event Season than the two winter seasons (82% compared to 74%), but more seasons will be needed to confirm the greater relative performance during summer seasons.

- **Recommendation:** As EV ownership increases, the driving patterns and charging needs of EV owners are likely to change. PGE should continue to monitor unmanaged charging baseline load through a randomly assigned control group to support distribution system planning. Continued research into charging load shapes and seasonal differences in managed charging performance will also allow PGE to tailor its managed charging interventions to support system needs.

Evaluability of evPulse: We conducted an equivalency analysis to determine if the control group created through the EVSE channel (Group A) was a good match for EVSE Groups B and C, as well as evPulse Group B. We compared the treatment groups to the control group on key characteristics such as TOD rate enrollment, other pilot enrollment, number of EVs, type of EV, as well as their non-event day charging patterns (weekends). This analysis showed that Group A is a good baseline for the EVSE Groups B and C but is not equivalent to evPulse. We provide estimates of EVSE channel load impacts using a fixed effects model in the body of the report. We provide estimates of charging load impacts for evPulse participants in Appendix A calculated as the straight differences between Group A and evPulse, but we do not have confidence in these results.

- **Recommendation:** To make the evPulse channel evaluable, the pilot should consider implementing one of the following design strategies:
  - Create a control group for the evPulse channel by randomly assigning a share of participants to the group upon enrollment, or
  - Withhold all charging interventions for all new evPulse enrollees for at least 30 days to establish a baseline.
- From an evaluation perspective, the control group approach is preferable because we can more easily control for seasonal differences in charging demand. Because all evPulse enrollees are assigned to Group B, which overlaps with the TOD peak rate period, we expect lower pilot impacts for TOD enrollees.

Event Opt-Outs: While the Residential Charging Pilot shifted a large amount of load relative to the baseline for all treatment groups, a small percentage of charging still took place during the pilot's event windows. The evaluation team defined event opt-outs as participants with greater than zero consumption during at least one hour of their PGE event window. Due to data limitations, we were unable to determine whether instances of event nonperformance were due to technology and event execution issues or customer behavior. Opting out (i.e., charging during a participant's event window) is not common. A majority of participants never or rarely opted out while a small percentage did so frequently. Across all three seasons, between 17% and 18% of participants never opted out of a single event, and between 44% and 55% of participants opted out of less than 10% of all events. A small share of participants—between 14% and 17% depending on the event season—opted out of 20% of event days or more. Group C participants were more likely to opt out, while Group B EVSE participants were least likely.

- **Recommendation:** If PGE would like to understand the reasons for charging during event windows, consider conducting additional research with participants who continually opt-out of events.

I.2.2 BUSINESS CHARGING REBATES PILOT

Pilot Awareness and Marketing: Business Charging Rebates Pilot marketing and outreach activities have been sufficient given the pilot budget, although there may be opportunities to increase participation. In alignment with how the pilot is marketed, participants generally learn about the pilot from PGE staff or the PGE website. The pilot's limited marketing

and outreach activities have resulted in about one-third of PGE's commercial customers being aware of the pilot. Pilot staff noted they have not seen commercial customers come over from other PGE offerings, such as the Fleet Partner Pilot, suggesting an opportunity for more cross-pilot promotion. Further, customer outreach staff indicated a need for additional information and updates about PGE's TE offerings (i.e., Fleet Partner Pilot and Drive Change Fund) to ensure that customers they work with are aware of these offerings.

- **Recommendation:** Ensure that PGE account representatives are aware and knowledgeable of the Business Charging Rebates Pilot to inform commercial customers about the opportunity. Consider providing periodic email updates or presentations to account representatives to inform them about new offerings and updates to existing offerings.

Pilot Participation and Rebate Levels: The Business Charging Rebates Pilot has been successful at increasing participation in 2023 and serving underserved communities. Changes to pilot offerings in 2022 have resulted in increased participation, which has primarily included properties offering mixed-use (i.e., fleet, multifamily, public, and workplace) and public charging options. Further, the pilot has been successful at reaching underserved customers, as most installed chargers are located in underserved communities. Pilot rebate levels appear sufficient to meet current demand but could be adjusted depending on market conditions. As of April 2023, new customers applying to the Business Charging Rebates Pilot could only receive rebates for qualified charging equipment and not for make-ready infrastructure. Customers who had previously reserved a spot in the Pilot can still receive a rebate for make-ready infrastructure in 2024. Most participants are early adopters of EV charging and indicated they would have installed charging without the financial assistance they received from PGE. Since many existing commercial properties require make-ready infrastructure before installing charging, additional make-ready support may be necessary for expanding pilot participation to those less willing or able to pay the full costs of installation.

- **Recommendation:** Continue to offer rebates for chargers, but also consider reinstating financial support for make-ready infrastructure to increase charging access at commercial properties, particularly for those properties serving underserved communities.

Pilot Satisfaction and Participation Challenges: Business Charging Rebates Pilot participants expressed high levels of satisfaction with their experience with the pilot; however, some participants shared concerns about the participation requirements, and some experienced challenges communicating with pilot staff or EVSE vendors. Participants expressed concerns about: the requirement to maintain chargers for 10 years, sharing charging data with PGE, selecting PGE-qualified chargers that would be best suited for their property, and finding an EVSE vendor with sufficient quantities of qualified chargers. Participants also mentioned challenges with communication, particularly obtaining PGE assistance with the application process and inconsistent communication from charging vendors. In 2023, the pilot introduced a new online application portal to make it easier for participants to apply and submit supporting documentation.

- **Recommendation:** Consider offering additional technical assistance to commercial customers to ease the process of selecting and procuring chargers. In the 2024 evaluation, continue to monitor participant satisfaction to see if changes to the application portal have improved customer satisfaction.

Charger Energy Consumption and Utilization: Business Charging Rebates Pilot charger energy consumption has increased steadily throughout the study period as the number of charging ports increased, peaking at 23 MWh in June 2023.[5] Both charger energy consumption and utilization appear to vary considerably by site use (i.e., fleet, multifamily, public, and workplace charging). Due to the relatively small number of sites with available charging data (n=33), differences in energy consumption and utilization may be due to the charging of specific pilot participants rather than trends in site types. In terms of energy consumption, sites used for fleets, workplace, and mixed usage generally have

[5] The study period includes charging data from January 2021 through the end of August 2023.

peaks during working hours, while public and multifamily sites appear to be more evenly distributed throughout the day. Further, sites used for fleet charging had significantly higher port utilization rates compared to other site uses.

- **Recommendation:** Evaluation results suggest variations in charging behaviors by site use. PGE should continue to monitor charger energy consumption and utilization as more Business Charging sites come online to better establish baseline charging metrics by site use. Pilot participant research in 2024 should also explore how charger use varies by site type and the reasons for variation. Findings from this research can help inform the design of future managed charging offerings for commercial customers.

I.2.3 FLEET PARTNER PILOT

Pilot Awareness and Marketing: Leveraging PGE staff's knowledge and existing relationships with customers to promote the Fleet Partner Pilot has been effective at generating awareness. Most projects supported by the pilot were initiated by PGE staff, with few customers reaching out directly to PGE to inquire about electrification offerings. Even though pilot outreach efforts were paused in late 2022, Key Customer Managers (KCMs) and business outreach staff mentioned challenges with staying up to date on current TE offerings and suggested better coordination between KCMs and pilot staff, so KCMs can better assist with the application and enrollment process.

- **Recommendation 1:** Continue providing regular updates to KCMs and business outreach staff about current TE offerings and updates on program requirements and incentive levels. Because KCMs and business outreach staff have established relationships with customers, consider closer coordination during the participation process, including involving staff in project kickoff meetings and providing project status email updates.
- **Recommendation 2:** If additional funding becomes available, PGE could consider exploring alternative ways of engaging with fleets in its service territory. This could include connecting with fleet managers through resources that fleet managers report using, including online fleet management resources, industry publications, conferences and expos, and social media (i.e., LinkedIn).

Pilot Requirements: The Fleet Partner Pilot's new load and easement requirements were challenging for participants. Fleet managers recalled that meeting the minimum 70 kW of new load requirement was not possible, leading some managers to withdraw their participation. An additional pilot requirement that posed a challenge for some participants was signing property easements for the make-ready infrastructure. Participants had concerns about the liabilities to the property owners for signing the easement, some of whom experienced significant delays due to prolonged negotiations between PGE's legal team and customers' landlords to address those concerns.

- **Recommendation 1:** Since the Fleet Partner Pilot is targeted towards larger customers, PGE may want to consider developing additional offerings to customers with smaller fleets. In the meantime, direct customers with smaller fleets to the Business Charging Rebates Pilot through additional marketing and coordination with business outreach staff and KCMs.
- **Recommendation 2:** Consider providing additional information to potential participants about the easement requirement, highlighting the importance of the easement in PGE's ability to maintain the make-ready infrastructure. As the easement process can result in lengthy legal reviews, ensure the process starts early to limit impacts on project timelines. Customers who are not the property owners may require additional assistance to obtain easements from the property owners.

Pilot Funding and Project Timelines: Fleet Partner Pilot staff mentioned two key challenges that the pilot faced in 2023: a shortfall in available funding and supply chain issues. By January 2023, funding for make-ready build-out was exhausted, leading to some customer frustration. Funding has since been reinstated, with reductions in incentive levels. Additionally, staff mentioned challenges with extended delays in procuring equipment, including transformers and

switchgear, leading to elongated project timelines. Interviewed build phase participants echoed this, mentioning that completion dates were set back for up to six months due to supply chain issues. Pilot staff have worked to address this issue by ordering equipment ahead of time to limit the impact on project timelines.

- **Recommendation:** Most utilities do not have control over the procurement schedule for customer project components. As a best practice, some utilities have started to keep an inventory of residential and commercial project components to mitigate the risks of significant delays to project timelines. In addition to ordering equipment well in advance, PGE could consider stockpiling critical project equipment to further decrease project timelines.

Technical Assistance and Total Cost of Ownership (TCO) tool: Fleet Partner Pilot participants expressed high levels of satisfaction with their experience with the pilot; however, some suggested a need for additional technical support and tools. Additional technical support suggested included additional detail on results from the charging, fuel cost, and energy use analysis, and assistance in determining the optimal number of chargers needed for their fleet. PGE's Total TCO tool is a free fleet planning tool that provides initial fleet analysis, including costs, energy use, and chargers needed. Several fleet managers reported using PGE's TCO tool and generally found it useful but desired additional features that capture demand charges and how projected energy usage may impact their monthly bills. Additionally, some fleet managers who used the TCO tool noted that cost estimates they received in their Fleet Study deviated from estimates they received from the TCO tool. They speculated that the deviations may have been a result of the TCO tool not accounting for all the potential factors that determine costs, including the impacts of ongoing inflation and labor costs.

- **Recommendation**: To the extent possible, ensure the online TCO tool accurately accounts for all factors associated with fleet electrification costs. When there are significant deviations between the TCO tool and preliminary costs in the Fleet Study, ensure that participants understand the reasons for the deviations.

Charger Energy Consumption and Utilization: During the study period, only three Fleet Partner Pilot participant sites consisting of 17 chargers had available charging data. Charger energy consumption for these three sites peaked at 1,039 kWh in August 2023. The load factor of charging across all sites also increased throughout the study period but remained relatively low. Charger utilization at participant sites was generally low, ranging from 2%–4%.

- **Recommendation:** PGE should continue to monitor charger energy consumption and utilization as more Fleet Partner Pilot sites come online to better establish baseline charging metrics.

2. INTRODUCTION

2.1 BACKGROUND

PGE has been working towards promoting greater electrification of the transportation sector by developing and implementing a wide range of programs. These programs are designed to cater to the needs of residential customers (single and multifamily), private and public fleet operators, municipalities, and businesses. In late 2018, PGE launched a coordinated set of pilot programs focused on customer outreach and education about EVs and charging called the Outreach, Education, and Technical Assistance Pilot. Additionally, PGE expanded public charging infrastructure through its Electric Avenue Pilot and electrified mass transit through its Electric Mass Transit 2.0 Pilot. Based on learnings from these initial three Pilots and other research conducted by PGE, PGE introduced three new pilots starting in 2020: Residential EV Smart Charging ("Residential Charging"), Business EV Charging Rebates ("Business Charging"), and Fleet Partner. Together, these Pilots contribute to a transportation ecosystem, where:

- Charging is accessible and adequate, reliable, affordable, and equitable;
- Businesses, organizations, and municipalities can achieve their emissions goals through electrification;
- EVs are efficiently integrated into the electrical grid, minimizing growth in system peak energy requirements; and,
- Electric mobility is available to all including historically underserved communities.

The following sections provide a summary of each Pilot along with their respective objectives and key activities.

2.1.1 RESIDENTIAL CHARGING PILOT

PGE launched its Residential Charging Pilot in 2020, with the first event season starting in October 2021. The pilot's objective is to shift EV charging away from peak times when energy use is high and sustainable energy sources are scarcer. In exchange for rebates for Level 2 EV supply equipment (EVSE/chargers) and the opportunity to earn a seasonal electric bill credit, Pilot participants allow PGE to control their EV charging during defined event hours.[6] The pilot stops charging during these event hours on every non-holiday, weekday of each season. The winter season runs from October to March and the summer season from April to September. Enrolled customers are eligible for a $25 seasonal bill credit by participating in events.[7] In addition to EVSE rebates, the Residential Charging Pilot also provides rebates to customers who require upgrades to their electrical panel to install Level 2 chargers.[8]

Table 3 shows key Pilot design features. Participants are assigned to one of three groups. Participants in Group A, the control group, do not have their EV charging curtailed on event days. The pilot design has two different event time windows. Group B participants have their charging curtailed from 5:00 p.m. to 8:00 p.m. on event days and Group C has their charging curtailed from 10:00 p.m. to 11:59 p.m. on event days.

Group B is further divided into two subgroups, based on the charging control technology used by the participants. EV drivers can participate in the pilot through a qualified networked (Wi-Fi®-connected) Level 2 charger or through vehicle

[6] Customers received a $500 rebate ($1,000 for income-eligible customers) for the purchase and installation of a qualified Level 2 charger at their home. The non-income-eligible charger rebate amount decreased to $300 in October 2023. Customers who purchase and install a Level 2 charger prior to it being added to PGE's Qualified Products List can receive a $50 rebate. Customers that drive a qualified vehicle but have a non-qualified EV charger can enroll to the pilot through vehicle telematics (evPulse) and receive a $50 rebate.

[7] To be eligible for the seasonal bill credit, customers must have their charger connected to the internet 50% of the time, charge their vehicles at least 13 times a season, and participate in at least 3 events during a season.

[8] Customers who apply for the standard rebate can receive up to $1,000 and income-eligible customers can apply to receive up to $5,000 towards the cost of their panel upgrade.

telematics (the vehicle's onboard communication system). Qualified EVSE manufacturers for participating drivers include ChargePoint, FLO, and Enel X. Customers with qualified chargers are randomly assigned to Groups A, B, or C. Most Tesla owners have a Tesla charger and are not eligible to participate using their chargers. Instead, Tesla owners participate via onboard vehicle telematics using WeaveGrid's software product, evPulse.[9] All Tesla owners who participate via evPulse are assigned to Group B.[10]

Pilot participants can also participate in other PGE programs that encourage them to shift their usage to times of the day with less demand. The residential TOD time varying pricing plan has three pricing periods, with the highest rate during the on-peak period from 5 p.m. to 9 p.m., a mid-peak period that runs from 7:00 a.m. to 5:00 p.m., and an off-peak period that runs from 9 p.m. to 7 a.m. The Peak Time Rebates (PTR) Pilot is a behavioral demand response program that pays customers to reduce their electric use over several hours on select days. The PTR summer season runs from June 1 through September 30 and the winter season runs from November 1 through February 28. PTR events can last from two to five consecutive hours and can occur between 7:00 a.m. and 11:00 a.m. or 3:00 p.m. to 8:00 p.m. during non-holidays. Upon enrollment, the pilot assigns EVSE channel customers who also participate in TOD and/or PTR to Groups A or C to avoid overlap with the Residential Charging Pilot event window. Because all evPulse participants are assigned to Group B, there is an overlap between event windows for participants who also participate in TOD and/or PTR. Participants who are on the TOD rate could have less curtailable EV charging load during Group B's event window, limiting the potential impacts of the Residential Charging Pilot.

Table 3. PGE Residential Charging Pilot Design

Group	Channel	Event Hours	Additional Pilot Participation
A (Control)	EVSE	NA	TOD/PTR
B	EVSE	5:00 p.m. – 8:00 p.m.	NA
B	evPulse Vehicle Telematics	5:00 p.m. – 8:00 p.m.	TOD/PTR
C	EVSE	10:00 p.m. – 11:59 p.m.	TOD/PTR

2.1.2 BUSINESS CHARGING REBATES PILOT

PGE launched its Business Charging Rebates Pilot in 2020 with the objective of accelerating EV adoption by ensuring adequate charging infrastructure is available to meet commercial customers' charging needs, reducing the cost and complexity of installing EVSE, and creating a network of demand response (DR)-enabled EVSEs to support efficient grid operations and future integration of renewables. The pilot program was introduced with a standard rebate to commercial customers of $500 per Level 2 port, which later was increased to $1,000 per port in July 2021. Additionally, an income-qualified multifamily rebate of $2,300 per port was introduced, which was extended to all multifamily sites in November 2022. In November 2022, the pilot expanded to also include make-ready installation rebates and rebates for direct current fast chargers (DCFCs) up until April 2023, when funding for these rebates was fully reserved. In exchange for the rebate, customers agree to keep the EVSE operational and on a PGE cost-of-service rate for a period of 10 years, as well as release the charger data to PGE for analysis and reporting purposes.

2.1.3 FLEET PARTNER PILOT

PGE launched its Fleet Partner Pilot in 2021. There are multiple objectives of this Pilot, namely, to reduce costs and complexities for managers of nonresidential fleets who are interested in transitioning to electric fuel. Additionally, there

[9] All product or company names that may be mentioned in this publication are tradenames, trademarks, or registered trademarks of their respective owners.

[10] PGE cannot confirm the original rational for this approach due to staff departures. PGE recognizes the groups are not ideal for evaluating performance and is working to address for future evaluations.

is an aim to create a network of DR-enabled EVSEs that can support efficient grid operations and future renewables integration. There are two participation phases of the Fleet Partner Pilot:

- **Fleet Partner Plan Phase:** Includes EV feasibility assessments, vehicle operations and charging analyses, fuel cost and clean fuel credit analyses, site walkthroughs, design and cost estimates, and incentive summary delivered in a comprehensive Fleet Partner Study.
- **Fleet Partner Build Phase:** Fleet customers who complete a Fleet Partner Study can join the reservation list for the Build phase, which includes turnkey final design, construction of make-ready infrastructure, incentives, and PGE ownership of make-ready infrastructure.

In the pilot, PGE covers up to $750,000 depending on the customer's energy commitment. Charging site(s) must be in PGE service area and fleet customers are responsible for charger costs, annual maintenance costs, electricity costs, and any make-ready costs not covered by the custom cost incentive. The pilot requires a make-ready design of at least 70 kW of connected load, and that participants share charging data with PGE for 10 years, commit to the forecasted energy use of the chargers, and sign an easement covering PGE-owned infrastructure, as well as agree to terms of Participation Agreement.

2.2 EVALUATION OBJECTIVES AND ACTIVITIES

This evaluation report covers pilot activities running from each pilot's inception through the second quarter of 2023. Results are reported for evaluation activities conducted between April 2023 to October 2023. Primary data collection activities conducted in 2023 included interviews with pilot staff and partners, a post-event survey to Residential Charging Pilot participants, interviews with Business Charging Rebates Pilot participants, surveys with Fleet Partner Plan phase participants, and interviews with Fleet Partner Build participants.[11] In addition to primary data collection, the evaluation team also conducted impact analyses that included residential load impacts, commercial and residential charging pattern analyses, and Pilot participation analysis. The participation analysis was similar across Pilots and used Pilot participation data to assess the demographics and firmographics of Pilot participants, the timing of sign-ups in relation to the marketing activities to assess marketing effectiveness, and, using PGE-provided GIS shapefiles, determining how many Pilot participants are located in underserved communities as defined by Oregon House Bill 2165 (HB2165).[12] The following sections provide details on primary data collection and impact analysis conducted in 2023.

We will submit a second evaluation report in November 2024. The report will cover Residential Charging Pilot activities conducted during the Summer 2023 and the Winter 2023/2024 event seasons. For the Business Charging Rebates Pilot and Fleet Parter Pilot, the 2024 report will cover pilot activities conducted from the third quarter of 2023 through the second quarter of 2024. Evaluation activities will include two additional waves of a post-event survey with Residential Charging Pilot participants, surveys with Business Charging Pilot participants, surveys with Fleet Partner Plan phase participants, and interviews with Fleet Partner Build participants, in addition to residential and commercial charging impact analyses.

[11] This report only includes results from one of the two waves of residential post-event surveys in 2023. At the time of this report, the 2nd wave of the post-event survey was being fielded. Results from that survey will be included in the 2024 evaluation report.

[12] Underserved communities are defined by HB2165 and include census tracts that contain high proportions of renters, multifamily housing, communities of color, low-income households, tribal communities, rural communities, and other communities adversely harmed by environmental health hazards. PGE developed GIS shapefiles that identified census tracts with high proportions of each of the above criteria, which the evaluation team used to flag Pilot participants who met at least one of the criteria.

2.2.1 RESIDENTIAL CHARGING PILOT

PROCESS ANALYSIS

The process analysis for the Residential Charging Pilot leveraged the following primary data collection activities:

- In-depth interviews with PGE staff involved with the pilot and implementation partners.
- Online post-event surveys with Winter 2022/2023 Event Season participants.

The evaluation team conducted an in-depth interview with PGE program staff in April 2023 to discuss key aspects of pilot implementation and identify priorities for upcoming research efforts and future pilot offerings. We then met with PGE's marketing specialist in May 2023 to learn more about pilot outreach and recruitment efforts, and in June 2023 we met with staff from implementation partners involved in operating each channel of the Residential Charging Pilot. These implementer interviews included a conversation with WeaveGrid to better understand the operation of the evPulse channel, including its charging optimization component, and the availability of charging data for evPulse participants. We also spoke to Generac staff about their role in registering, facilitating, and tracking EVSE channel participation.

Conversations with program staff and implementation partners helped inform the development of a post-event survey, which we fielded with a sample of Winter 2022/2023 season participants. The survey solicited customers' feedback regarding their experiences with all stages of enrollment and participation in the pilot, their EV charging habits, and the pilot's influence on charging behavior. The survey covered the following topics:

- Awareness of pilot marketing and outreach activities;
- Satisfaction with the participation processes and outreach efforts;
- Awareness of and satisfaction with pilot communication during the event season;
- Challenges with participation in DR events;
- Experience using EV charging mobile and web applications;
- Influence of the pilot on charging behaviors and patterns;
- Reasons for overriding or opting out of events;
- Awareness of qualification requirements for seasonal incentives; and
- Satisfaction with seasonal incentive award and accuracy of qualification tracking.

We attempted a census of all participants in the Winter 2022/2023 Event Season, including both the EVSE and evPulse channels and from the treatment and control groups.[13] To minimize participant recall issues, we fielded the survey in the months immediately following delivery of Winter 2022/2023 Event Season bill credits. We reached out via email, contacting each participant up to three times between July and August 2023, inviting them to complete an online survey. The sample included 2,524 pilot participants (after excluding duplicate accounts and records with incomplete information for sampling purposes), 944 of whom completed the survey for a yield of 37% and a response rate of 39%. The distribution of completes across channels and groups is representative of the overall population (the relative contribution of each channel/group to completes is within 5% of their respective contribution to the population). Table 4 summarizes the number of participants included in the sample and the number of survey completions by channel and group.

[13] As part of survey sample development, we excluded a small number of records to omit duplicate contacts, participants who unenrolled prior to the end of the event season, and those with inconsistent or missing group membership.

Table 4. Residential Charging Pilot Post-Event Survey Fielding Summary

Channel	Group	Sample	Completes	Yield
EVSE	A (Control)	393	177	45%
	B (5:00 p.m. – 8:00 p.m.)	372	143	38%
	C (10:00 p.m. – 11:59 p.m.)	630	257	41%
evPulse	B (5:00 p.m. – 8:00 p.m.)	1,129	367	33%
Total		2,524	944[a]	37%

[a] Includes 67 partially completed surveys that were included in our analysis.

IMPACT ANALYSIS

The overarching objectives of the impact analysis of the Residential Charging Pilot are to estimate the impact of the pilot on shifting EV charging load and explore the drivers of event performance for the Winter 2021/2022, Summer 2022, and Winter 2022/2023 Event Seasons. We also examined charging patterns of pilot participants through the construction of charging load shapes. Specifically, our analysis provides information about:

- Average per vehicle/charger and overall pilot event hour load impacts;
- Hourly degradation within events;
- Frequency of charging during events (opt outs);
- Average hourly electricity consumption over a 24-hour period by weekday, weekend, and season;
- Variations in load across key characteristics (i.e., TOD, group, home vs. away-from-home charging, etc.); and
- Aggregated on-peak and non-coincident peak consumption.

We utilized participant data provided by PGE, including enrollment and de-enrollment records for vehicles and chargers starting in 2020. For the load impact and charging pattern analysis, we leveraged two distinct pathways—EVSE charger telemetry interval data from Generac for ChargePoint, FLO, and Enel X EVSEs, and charging telemetry interval data from WeaveGrid for evPulse participants. The dataset from WeaveGrid included additional variables from the vehicle telematics system including vehicle identification and plug location (a flag for whether the vehicle was charging at home or away from the owner's residential address).

The available data had several limitations. The EVSE charger telemetry data were missing for Group A for October 2021, and as a result, we excluded October 2021 from the impact analysis. Additionally, there were other missing data across groups (usually the last few days or hours of a month). We determined that this small amount of missing data did not greatly impact results and used the data available for each period when modeling savings and charging patterns.

We conducted a thorough review, cleaning, and preparation of the data for analysis (see Appendix A for details). After data cleaning and preparation, we created and examined charging load shapes and patterns of pilot participants. We assessed key differences in charging patterns between unmanaged charging, represented by the pilot's control group (Group A) and managed charging for each of the treatment groups (Groups B and C). We also identified charging differences by enrollment channel (EVSE and evPulse), participation in other PGE programs (TOD and PTR), event season, different vehicle types, and other key segments.

Before estimating program impacts, we conducted an equivalency analysis to determine if the control group created through the EVSE channel (Group A) was a good match for EVSE Groups B and C as well as evPulse Group B. We compared the treatment groups to the control group on key characteristics such as TOD rate enrollment, other pilot

enrollment, number of EVs, type of EV, as well as their non-event day charging patterns (weekends). This analysis showed that Group A is a good baseline for the EVSE Groups B and C but is not equivalent to evPulse.[14]

We used a fixed effects model to estimate kW load reduction due to the pilot for the EVSE channel. We excluded evPulse from the modeled results due to inequivalence with the control group (Group A) but provide alternative results calculated as simple differences between the treatment and control groups in Appendix A for all groups and enrollment channels, including evPulse.

We conducted additional analyses to understand the prevalence of event opt-outs to better understand event performance. We defined an event opt-out as participants that have greater than zero consumption during at least one hour of their PGE event window. For evPulse, away charging is excluded from this exploration since charging is not curtailed when the vehicle is not at home. We received hourly data for the EVSE channel and 15-minute data for evPulse. Given the level of data aggregation, we could not identify customers who charged for just a few minutes. Due to data quality issues with the provided charger connectivity reports, we could not determine whether charging during an event window was due to customer behavior or technological failure.

Additional details about our data cleaning and preparation process, equivalency analysis, opt-out analysis, and load impact and charging pattern analysis methodology can be found in Appendix A.

2.2.2 BUSINESS CHARGING REBATES PILOT

PROCESS ANALYSIS

The process analysis for the Business Charging Rebates Pilot leveraged the following primary data collection activities:

- In-depth interviews with PGE staff involved with the pilot
- In-depth interviews with participants who received rebates through the pilot

Three in-depth interviews with PGE staff who were involved with the Business Charging Rebates Pilot were conducted between April and May 2023. The interviewed staff included the product manager, marketing personnel, Key Customer Managers (KCMs), and business outreach personnel. The main objective of these interviews was to gather comprehensive details about pilot implementation, successes, challenges, expected outcomes, and suggestions for improvement.

Between August and September 2023, additional in-depth interviews were conducted with participants who received rebates through the pilot. The purpose of these interviews was to gather information about participants' businesses and their motivations for installing EV charging, document any challenges faced during the procurement and installation of chargers, and assess their level of satisfaction with the pilot program. The interviews covered the following topics:

- How participants learned about the pilot;
- The role that the pilot had on the decision to install EV charging;
- Satisfaction with the pilot process and support services provided;
- Details about the EV charging setup, including types of users and payment structure; and
- Financial costs and benefits of having installed EV charging and operational challenges.

The 25 organizations that received rebates through the pilot between August 2021 and July 2023 had email requests sent to them to complete their interview. Non-responders to email outreach were contacted via phone. In total, the

[14] PGE recognizes the groups are not ideal for evaluating performance and is working to address for future evaluations.

evaluation team completed 10 interviews resulting in a 40% response rate (Table 5). All interviewees were offered a $50 incentive for completing the interview.

Table 5. Business Charging Rebates Pilot Participant Interview Dispositions

Disposition	Count
Completed interview	10
No response	12
Refusal	3
Total	**25**

IMPACT ANALYSIS

The overarching objective of the impact analysis of the Business Charging Rebates Pilot is to provide PGE with information about EV charging patterns so it can plan for system impacts from EV load growth and develop appropriate load management strategies. Specifically, our analysis provides information about:

- Average hourly electricity consumption;
- Total electricity consumption during study period;
- Aggregated on-peak and non-coincident peak consumption;
- Variation in energy consumption by customer segment; and
- Charging port utilization rates.

The Business Charging Rebates Pilot impact analysis leveraged charging data from commercial customers and charging vendors compiled in PGE's non-residential charger database to develop key charging metrics and average aggregate load curves of participants.[15] The analyses required both session and interval data, but only session data were initially available. Therefore, PGE created interval data from the session data, which was verified by the evaluation team. The Business Charging Rebates Pilot impact analysis covers from January 1, 2021, through the end of the reporting period (August 31, 2023).

The available data had some limitations. PGE staff shared that one vendor was unable to provide charging start and end times for charging sessions but was able to provide plug start and end time as well as charging duration. PGE staff reconciled this limitation by determining that missing charging start times should be filled in using plug start time. Further, charging end time should be calculated by adding the charge duration to the new charge start time. This approach assumes that charging begins as soon as a vehicle is plugged in, which may not always be the case due to driver preferences programmed into the vehicle or charging issues. Given that it is non-residential charging, PGE staff felt comfortable making the assumption that charging would begin as soon as the vehicle is plugged in. The charging start and charging end times were used by PGE staff to generate the time series data used in analyses.

Additional details about the data cleaning and preparation process used, as well as detailed load impact and charging pattern analysis methodology, can be found in Appendix B.

[15] PGE's charger database and online charger registration form were developed in early 2023. For chargers installed prior to 2023, either the customer registered the chargers in 2023 and listed an earlier install date, or charger information was collected using program information (i.e., Business Charging Rebate applications). Once chargers were added to the database, PGE worked with those charging vendors to collect charging session data. For some vendors, it took several months until they were able to start consistently sending session data, and any data prior to that point is not available. Other vendors were able to provide session data back to when the charger was first installed.

2.2.3 FLEET PARTNER PILOT

PROCESS ANALYSIS

The process analysis for the Fleet Partner Pilot leveraged the following primary data collection activities:

- In-depth interviews with PGE staff involved with the pilot;
- In-depth interviews with fleet managers who inquired about and applied for the Fleet Partner Pilot, but later withdrew their application;
- Online surveys with fleet managers who completed the Plan phase of the pilot; and
- In-depth interviews with fleet managers who completed the Build phase of the pilot.

The evaluation team completed interviews with eight staff and implementers involved with the Fleet Partner Pilot between April and May 2023. The main objective of these interviews was to gather insights into pilot implementation, successes, challenges, expected outcomes, and suggestions for improvement. The product manager, KCMs, engineering, marketing, and business outreach staff were interviewed.

In May of 2023, the evaluation team conducted in-depth interviews with fleet managers who inquired about and applied for the Fleet Partner Pilot, but who later withdrew their application. The interviews with inactive participants included questions about pilot marketing efforts, reasons for withdrawing from the pilot, participation challenges that PGE could address, the appropriateness of the custom incentive for make-ready infrastructure, and the usefulness of the online Total Cost of Ownership (TCO) planning tool. Interviewees were recruited via email from a PGE-provided list of five contacts who withdrew from the pilot (detailed findings from those interviews can be found in Appendix D). All inactive participant interviewees were offered a $100 incentive for completing the interview.

Between August and September 2023, the evaluation team conducted online surveys with fleet managers who completed the Plan phase of the pilot and conducted in-depth interviews with those who completed the Build phase of the pilot. The objectives of the surveys and interviews were to document how participants learned about the pilot, the effectiveness of technical assistance received from PGE staff, challenges encountered with participating in the pilot, interest in future managed charging offerings, and satisfaction with the pilot. Survey and interview respondents were recruited via email from a PGE-provided list of 37 participants who completed the Fleet Plan phase and six participants who completed the Fleet Build phase. In total, nine Plan surveys and four Build interviews were completed, resulting in a 24% and 67% response rate, respectively (Table 6). All respondents and interviewees were offered a $50 incentive.

Table 6: Fleet Partner Pilot Participant Interview and Survey Dispositions

Disposition	Inactive Participant Interviews	Participant Survey (Plan Phase)	Participant Interviews (Build Phase)
Completed	4	9	4
No response	1	19	2
Undeliverable emails	0	3	0
Began Build Phase (to be interviewed in 2024)[a]	0	4	0
Refusal	0	2	0
Total	5	37	6

[a] Four pilot participants indicated they have moved on to the Build phase of the pilot and were exited from the survey. We plan to interview these participants in 2024 as part of our second wave of Fleet Partner Build interviews.

IMPACT ANALYSIS

Similar to the Business Charging Rebates Pilot, the overarching objective of the impact analysis of the Fleet Partner Pilot is to provide PGE with information about EV charging patterns so it can plan for system impacts from EV load growth and develop appropriate load management strategies. Specifically, the impact analysis provides information about:

- Average hourly electricity consumption;
- Total electricity consumption during study period;
- Aggregated on-peak and non-coincident peak consumption;
- Variation in energy consumption by customer segment; and
- Charging port utilization rates.

The Fleet Partner Pilot impact analysis leveraged charging data from PGE's non-residential charger database to develop key charging metrics and average aggregate load curves of participants. The analysis required both session and interval data, but only session data were initially available. Therefore, PGE created interval data from the session data which was verified by the evaluation team. The Fleet Partner analysis covers from June 6, 2023, through the end of the reporting period (August 31, 2023).

Additional details about the data cleaning and preparation process, in addition to detailed load impact and charging pattern analysis methodology, can be found in Appendix C.

3. RESIDENTIAL CHARGING PILOT FINDINGS

The following section provides detailed results of the Residential Charging Pilot post-event survey and charging load impact and pattern analyses. The period under evaluation covers three event seasons, running from the launch of the program in October 2020 through March 31, 2023 (i.e., the Winter 2021/2022, Summer 2022, and the Winter 2022/2023 Event Seasons). The post-event survey focused on participation during the Winter 2022/2023 Event Season.

3.1 PILOT PARTICIPANT CHARACTERISTICS

Customer enrollment in both the EVSE and evPulse channels of the Residential Charging Pilot has been strong. The pilot began enrolling participants on an ongoing basis into the EVSE channel in late 2020 and the evPulse channel enrollment began in late 2021.[16] During the Winter 2022/2023 Event Season, 2,717 chargers/vehicles were enrolled in the pilot across the two channels (Table 7). This is nearly double the enrollment from the Summer 2022 season and 150% increase from the pilot's first season (Winter 2021/2022).

Participation in the EVSE channel grew steadily, increasing 63% between the Winter 2021/2022 and Summer 2022 Event Seasons, and another 52% between the Summer 2022 and Winter 2022/2023 Event Seasons. Overall, the number of participants in the EVSE channel increased by 147% from 581 participants in the Winter 2021/2022 Event Season to 1,435 participants a year later. A total of 49 EVSE participants unenrolled from the pilot across the three event seasons.

Tesla drivers already participating in the Smart Grid Test Bed (Phase I) were enrolled into the evPulse channel in November 2021, quickly reaching the initial channel cap of 500 participants by the end of February 2022 (just three months after opening for enrollment), at which point enrollment halted until Q4 2022.[17] With no new enrollments during most of 2022, evPulse enrollment dropped slightly between the Winter 2021/2022 and Summer 2022 Event Seasons. When enrollment opened to customers outside of the Smart Grid Test Bed, enrollment increased by 179%, reaching 1,282 participants for the Summer 2022 Event Season. A total of 52 evPulse participants unenrolled from the pilot across the three event seasons.

Table 7. Residential Charging Pilot Participant Enrollment Trends

Metric	Winter 2021/2022	Summer 2022	Winter 2022/2023
Total			
Total participant count	1,084	1,407	2,717
Percent increase in participant season-over-season		+30%	+93%
EVSE			
Total participant count	581	947	1,435
Percent increase in participant season-over-season		+63%	+52%
evPulse			
Total participant count	503	460	1,282
Percent increase in participant season-over-season		-9%	+179%

[16] For the EVSE channel, a participant is an enrolled charger. Customers could enroll more than one charger; however, fewer than ten customers did so over three event seasons. For evPulse, a participant is an enrolled vehicle. Approximately 7% of accounts, enrolled more than one Tesla in evPulse.

[17] The Pilot did not expand evPulse enrollment to the full PGE service area until the Schedule 8 tariff was updated. PGE maintained a waiting list of interested customers to enroll after the tariff update.

The Residential Charging Pilot met its 2023 annual cumulative enrollment targets for unique chargers/vehicles (Table 8). With the pace of enrollment increasing since the cap on evPulse enrollment was lifted, the pilot has an opportunity to reach its 2024 enrollment goals as well.

Table 8. Residential Charging Pilot Participant Enrollment Compared to Goals

Year End	Cumulative Enrollment	Goal
2020	11	100
2021	482	1,550
2022	2,279	3,393
2023	4,529	4,200
2024	--	7,500

Source: Cumulative enrollment for 2020 through 2022 based on evaluation team analysis of PGE enrollment data, 2023 cumulative enrollment and goals provided by PGE pilot staff.

As part of the participation analysis, Opinion Dynamics examined data from the participant tracking data across the Winter 2021/2022, Summer 2022, and Winter 2022/2023 Event Seasons. We examined results from the Winter 2022/2023 post-event participant survey for characteristics not collected during participant enrollment or those that were not well-populated in the database. We present the key findings on participant composition trends from the program tracking data (Table 9) and the participant survey (Table 10) below.

Most EVSE participants received the standard charger rebate, and a small share of participants received the income-eligible charger rebate. The rebate mix remained largely unchanged over time. EVSE channel participants could qualify for one of several available charger rebates, dependent on income-eligibility and the model of their Level 2 smart charger.[18] Approximately 90% of all EVSE channel participants received standard charger rebates of up to $500 for installing a qualifying Level 2 smart charger and 8% qualified for income-eligible charger rebates of up to $1,000 (Table 9).[19] Another 2% received a $50 rebate for the purchase and installation of a Level 2 smart charger that was added to the qualified product list after it was already installed, referred to as Bring Your Own Charger (BYOC). The rebate mix remained largely unchanged over time. Beginning in November 2022, customers who received a charger rebate could qualify for an additional panel upgrade rebate if installation of a qualified Level 2 smart charger necessitated an upgrade to their home's electrical panel. In the first few months of the offering, seven non-income-eligible customers qualified for the $1,000 standard panel upgrade rebate, and two qualified for the income-eligible rebate of up to $5,000.

Enrollment in the TOD rate was high and steady among evPulse participants. TOD rate enrollment increased dramatically among the EVSE participants. Slightly under half of evPulse participants were enrolled in the TOD rate across all seasons (43% during the Winter 2021/2022 and Summer 2022 Event Seasons and 46% during the Winter 2022/2023 Event Season) (Table 9). TOD rate enrollment increased among the EVSE participants from 18% during the Winter 2021/2022 Event Season to 42% during the Winter 2022/2023 Event Season. Such a high share of TOD rate enrollment is not surprising, given that PGE was cross-promoting the TOD rate enrollment alongside the Residential Charging Pilot. Because the TOD rate intends to permanently shift load, rate enrollment could impact charging behaviors, and by extension, Residential Charging Pilot load impacts. We explore these effects in subsequent report sections.

Cross-enrollment in the PTR Pilot decreased over the course of the three event seasons for both the EVSE and evPulse channels. Between 12% and 20% of Residential Charging participants were also enrolled in the PTR Pilot, depending on

[18] Income eligibility was defined as 80% or less of state median income prior to November 2022, at which point the threshold changed to 120% to align with the HB2165 underserved community income definition.
[19] As of October 18, 2023, standard charger rebates have been reduced from $500 to $300. This change was made after the current evaluation period.

the event season (Table 9). Roughly 14% of all PGE's residential customers are enrolled in the PTR Pilot. Three Peak Time Rebate events were called during the Winter 2021/2022 Event Season, six during the Summer 2022 Event Season, and four during the Winter 2022/2023 Event Season. Participant charging behavior during event hours can differ in response to the PTR event signal and, therefore, impact the effectiveness of the Residential Charging Pilot on those event days. Given the small number of event days, we were able to exclude PTR event days from the impact analysis entirely, to more clearly isolate the impacts of the Residential Charging Pilot.

Approximately two-thirds of EVSE channel participants drive a battery electric vehicle (BEV) as opposed to a plug-in hybrid electric vehicle (PHEV) as their primary EV. The mix of BEVs versus PHEVs stayed roughly the same over the three event seasons (66% to 68% depending on the season) (Table 9). For the EVSE channel, the program tracking data contained information on the primary EV in the household. According to survey results, 17% of EVSE channel participants owned more than one EV at the end of the Winter 2022/2023 Event Season (Table 10).

Table 9. Residential Charging Pilot Participant Characteristics

Metric	Winter 2021/2022	Summer 2022	Winter 2022/2023
EVSE			
Percent Participant Distribution by Rebate Type			
Standard Charger Rebate	89%	90%	90%
Income-Eligible Charger Rebate	8%	7%	8%
BYOC	3%	3%	2%
Panel Upgrade	NA	NA	<1%
Cross Enrollment			
Enrolled in TOD	18%	32%	42%
Enrolled in PTR	24%	12%	18%
Total EVSE Participants	581	947	1,435
evPulse			
Enrolled in TOD	43%	43%	46%
Enrolled in PTR	28%	16%	20%
Total evPulse Participants	503	460	1,282

Among participants who took the Winter 2022/2023 post-event survey, most own more than one vehicle (82%), nearly three-quarters (72%) own an internal combustion engine (ICE) vehicle in addition to an EV, and approximately one-fifth own more than one EV (19%) (Table 10). According to the tracking data, a very small number of EVSE participants (four during the Summer 2022 season) enrolled more than one charger in the pilot, suggesting that the rest of the participants who had more than one EV used a single charger. evPulse tracking data showed that 7% of participating accounts had more than one Tesla enrolled in the pilot. We found little difference between EVSE and evPulse participants in the ownership of an ICE vehicle or the number of vehicles owned. However, EVSE participants are much more likely to own a PHEV than evPulse participants (29% vs. 4%).[20]

Participants in both channels of the Residential Charging Pilot are overwhelmingly middle- and high-income owners of single-family homes, consistent with expected demographics of EV owners given the relatively high upfront cost of most EVs. Less than 1% of pilot participants rent their home or live in a multifamily or mobile home. Approximately two-thirds had household incomes of more than $150,000 in 2022.

[20] The program tracking data contained information on the primary EV in the household. Customers who owned more than one EV could also provide information on secondary vehicles, but we found that these data were not well-populated when compared to the survey results for the same participants. Therefore, most of our reporting on vehicle ownership comes from the survey data. The program tracking data showed consistency over the event seasons on items related to the primary vehicle, such as the percentage that were BEVs versus PHEVs for the EVSE channel.

Table 10. Residential Charging Pilot Participant Characteristics (Post-Event Survey)

Metric		All	EVSE	evPulse
Vehicles	Have more than one vehicle	82%	82%	84%
	Have more than one EV	19%	17%	21%
	Have a BEV	83%	72%	100%
	Have a PHEV	19%	29%	4%
	Have an ICE vehicle	72%	72%	72%
Home Ownership	Own	99%	99%	99%
	Rent	<1%	<1%	<1%
Home Type	Single-family or townhouse	99%	98%	99%
	Multifamily building	<1%	1%	<1%
	Mobile, manufactured, or other	<1%	1%	<1%
Household Income	Less than $50,000	2%	3%	1%
	At least $50,000 and less than $100,000	11%	12%	11%
	At least $100,000 and less than $150,000	21%	21%	20%
	$150,000 or more	66%	64%	69%
Number of Respondents		944	577	367

The Residential Charging Pilot has been effective at reaching customers in underserved communities. The evaluation team mapped pilot participants to census tracts identified by PGE as containing high proportions of underserved customers as defined by HB2165 and found that approximately half (46%) of participants lived in one or more of the underserved community types (Table 11). Of the underserved community types, participants most frequently lived in communities of color, communities adversely harmed by environmental health hazards, and low-income areas.

Table 11. Proportion of Residential Charging Pilot Participants in Underserved Communities (PGE GIS Analysis)

Underserved Community Criteria	All	EVSE	evPulse
Communities of color	23%	19%	28%
Environmental health hazard area	16%	18%	13%
Low-Income communities	16%	17%	13%
Area with high proportion of renters	10%	11%	9%
Area with high proportion of multifamily	4%	4%	4%
Rural communities	2%	2%	1%
Tribal communities	0%	0%	0%
Any underserved community	46%	46%	47%

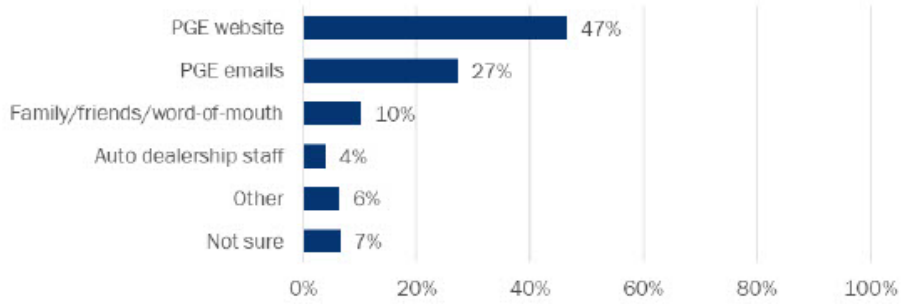
Note: Underserved community criteria are not mutually exclusive.

3.2 PILOT MARKETING AND ENROLLMENT

Since the launch of the Residential Charging Pilot, staff have designed and implemented wide-ranging marketing campaigns aimed at generating awareness of the pilot, sometimes in concert with broader efforts to promote EV adoption. These efforts initially included email campaigns, web advertising, occasional TV spots, ride and drive events, dealership referrals, and educational kiosks. During the past year, marketing primarily focused on email campaigns targeting likely EV owners based on load shape modeling and Oregon Driver and Motor Vehicle (DMV) records. Recent email marketing campaigns also placed emphasis on the availability of both charger rebates and seasonal charging incentives.

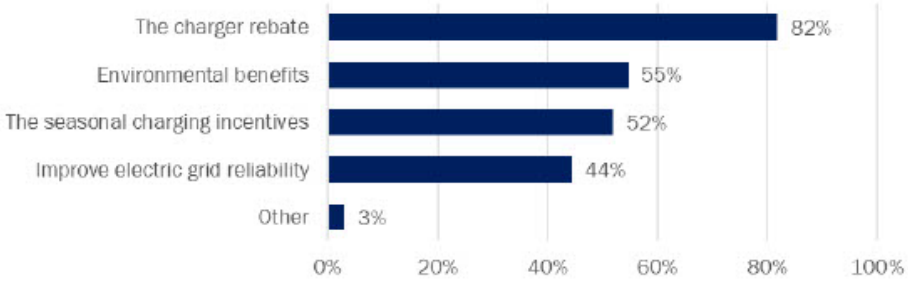
Feedback from surveyed participants suggests that current marketing priorities are well-aligned with customer preferences. When asked how they first learned about the Residential Charging Pilot, most respondents pointed to PGE's website (47%) or email outreach (27%; Figure 1). However, the vast majority suggested that they would prefer to receive information about future PGE EV offerings via email (89%), which is in line with PGE's more recent marketing priorities.[21]

Figure 1. Sources of Residential Charging Pilot Awareness (n=944)



Feedback from pilot participants suggests that future marketing should continue to highlight the various benefits of the pilot, emphasizing charger rebates as a key selling point. Residential Charging Pilot participants pointed to a range of motivations for enrolling in the Residential Charging Pilot, chief among them the charger rebate (82%, Figure 2). Notably, about half of respondents also indicated environmental benefits (55%) and seasonal charging incentives (52%) played a role in their decision to participate, and nearly as many expressed an interest in improving grid reliability (44%).

Figure 2. Motivation to Enroll in Residential Pilot (Multiple Responses Allowed; n=944)

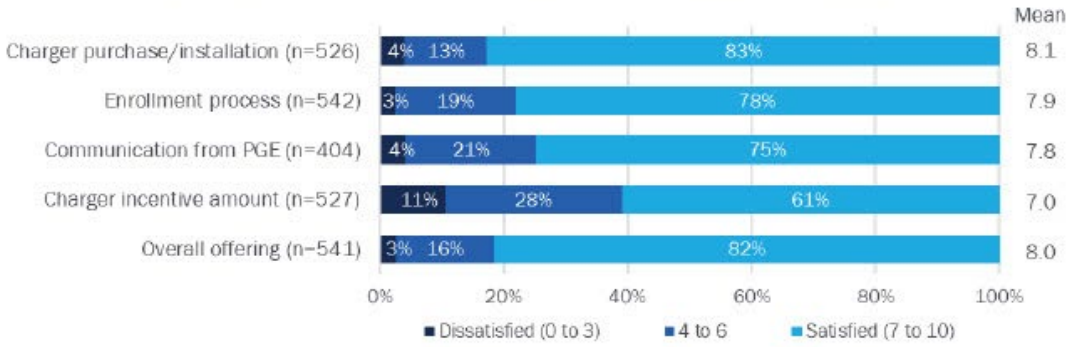


3.3 PILOT PARTICIPATION PROCESS

Surveyed EVSE channel participants expressed relatively high satisfaction with most pilot elements, providing an average rating of 8.0 out of 10 for the offering overall (Figure 3). Respondents reported similar levels of satisfaction with the process of purchasing and installing their new chargers, enrolling in the pilot, and communication received from PGE staff. Incentive amounts associated with charger rebates received slightly lower ratings with some participants wishing a higher portion of the charger purchase and installation was covered.

[21] A smaller portion of respondents also indicated they would like to hear about future PGE EV offerings via online advertising (9%) or via social media (8%). The survey mode (email/web) could conceivably bias these results towards online sources of information, but this is less likely given the high survey response rate.

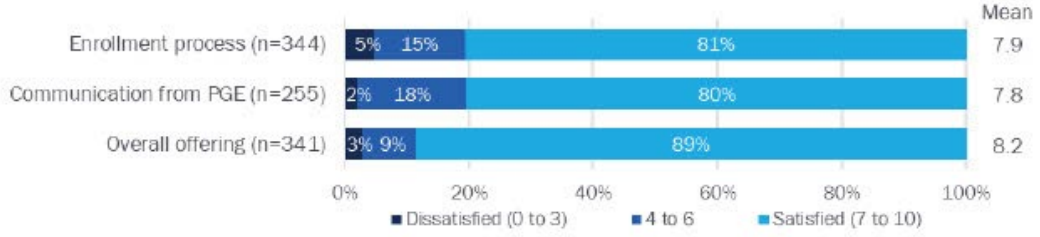
Figure 3. EVSE Channel Participant Satisfaction with Residential Charging Pilot



Note: Varying base sizes reflect exclusion of "not sure" and "not applicable" responses.

Similarly, surveyed evPulse participants reported high satisfaction with applicable aspects of the pilot, giving an average rating of 8.2 out of 10 for the offering overall (Figure 4). The vast majority of respondents expressed satisfaction with both the enrollment process and communication from PGE staff (81% and 80%, respectively). Five percent or fewer of evPulse respondents reported dissatisfaction with key program elements.

Figure 4. evPulse Participant Satisfaction with Residential Charging Pilot



Note: Varying base sizes reflect exclusion of "not sure" and "not applicable" responses.

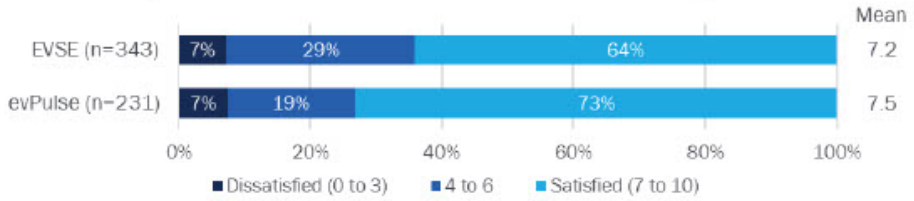
Those respondents who expressed dissatisfaction with key pilot elements typically pointed to the following issues:

- Among EVSE channel participants dissatisfied with charger purchase and installation, 35% pointed to complexity of installation and 19% pointed to difficulty finding a contractor (n=31)
- Those dissatisfied with the enrollment process primarily criticized the amount of paperwork required (64%, n=44)
- Those dissatisfied with program staff communication primarily pointed to non-responses (42%) or slow responses (17%, n=36)
- EVSE channel participants who expressed dissatisfaction with the charger incentive amount unsurprisingly suggested the incentive should be higher (80%, n=66))

Surveyed participants across groups and channels generally found monthly notification emails helpful. Most (82%) respondents recalled receiving monthly notification emails about upcoming events and seasonal charging incentive qualifications, and three-fifths (60%) of those who recalled the emails reported finding the notifications to be helpful. Among those who found the notifications unhelpful, the most common complaints were that emails did not affect their charging behavior (43%) or that the email was unnecessary (25%).

Most surveyed participants recalled receiving the $25 seasonal participation bill credit and expressed satisfaction with the amount provided, though a substantial portion were not able to identify all participation requirements. Nearly two-thirds of surveyed participants reported qualifying for and receiving the $25 bill credit following the Winter 2022/2023 Event Season (63% and 66%, respectively). However, more than one-third of EVSE (36%) and nearly half of evPulse (47%) channel participants were unable to correctly identify the seasonal incentive participation requirements. Among those who did not qualify for a seasonal incentive, just 27% felt that the notification email made clear what they would need to do differently to qualify in future seasons. Still, the majority of participants across both channels reported moderate to high levels of satisfaction with seasonal incentive amounts (Figure 5).

Figure 5. Satisfaction with Seasonal Bill Credit Amounts by Channel

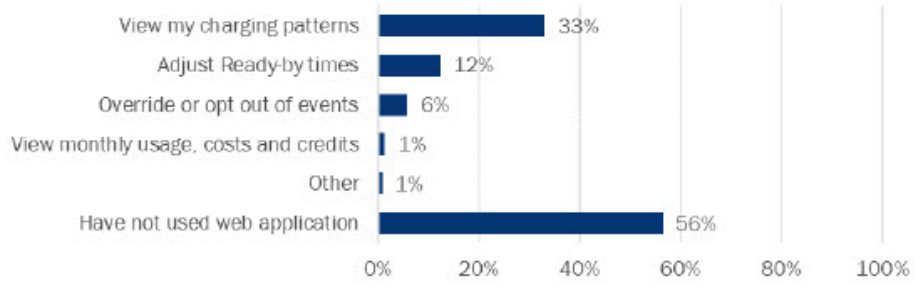


Note: "Not sure" responses are excluded.

Nearly all surveyed participants in the EVSE channel use EV charging mobile apps to control their home charging. The vast majority of EVSE channel participants use their charger's designated mobile app (90%) to control their charging, while a much smaller portion of respondents reported using their vehicle manufacturer's mobile app (3%). Fewer than one in ten respondents indicated they do not use any mobile app to control their vehicle's charging.

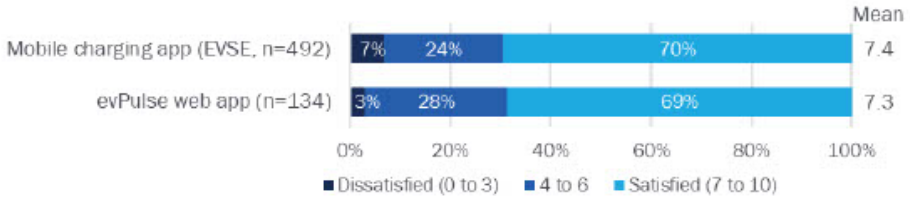
Among surveyed evPulse participants, fewer than half (44%) have made use of the designated evPulse web application. One-third (33%) of respondents reported using the evPulse web application to view their charging patterns, and smaller portions used it to adjust ready-by times (12%) or override DR events (6%; Figure 6). Those who have not used the evPulse web application often did not know it was available (38%), felt it was unnecessary (32%), or preferred another charging app (26%).

Figure 6. evPulse Participant Reasons for Using Designated Web Application (Multiple Responses Allowed; n=356)



Users of EV charging mobile apps and the evPulse web application express similarly high levels of satisfaction with each (Figure 7). EVSE channel participants provided an average satisfaction rating of 7.4 out of 10 for their experience with mobile charging apps, and evPulse web application users reported an average satisfaction rating of 7.3. Few respondents expressed dissatisfaction with either application, but those that did pointed to the mobile app's user interface (56%), glitches that affected charging (20%), or noted that they would prefer a mobile evPulse app to the existing web application (50%).

Figure 7. Satisfaction with Charging Applications by Channel



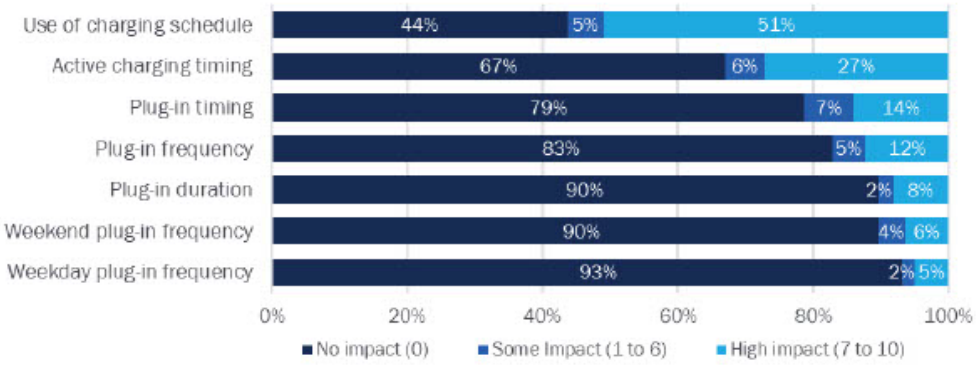
Note: "Not sure" responses are excluded.

3.4 CHARGING BEHAVIOR CHANGES

We asked respondents about the impact of the pilot on several different charging behaviors. To be eligible for the pilot's seasonal bill credit, customers must have their charger connected to the internet at least 50% of the time, charge their vehicles at least 13 times, and participate in at least 3 events during a season. Those with prior EV experience are likely to have a more informed sense of how pilot participation affected their charging tendencies so we framed the questions differently depending on length of EV ownership. For those who drove an EV for at least three months prior to enrolling, we asked whether their behavior changed after enrolling and, if so, the degree to which the pilot impacted that change. For those without prior EV experience, we simply asked them to estimate the degree to which the pilot impacted each charging behavior. We present results separately for those with and without prior EV experience and each channel.

Among EVSE channel participants with prior EV charging experience, the most commonly reported behavior change attributed to the pilot was to begin setting a charging schedule. Among EVSE channel respondents who reported owning an EV for at least three months prior to enrolling in the pilot (39% of all EVSE channel respondents), about half (51%) reported that enrolling in the pilot was highly impactful on their decision to begin setting a charging schedule. (Figure 8). Slightly over one-quarter (27%) indicated it was highly impactful on the timing of their active charging.

Figure 8. EVSE Participant Changes to Typical Charging Behavior After Enrolling (Multiple Responses Allowed; n=221)

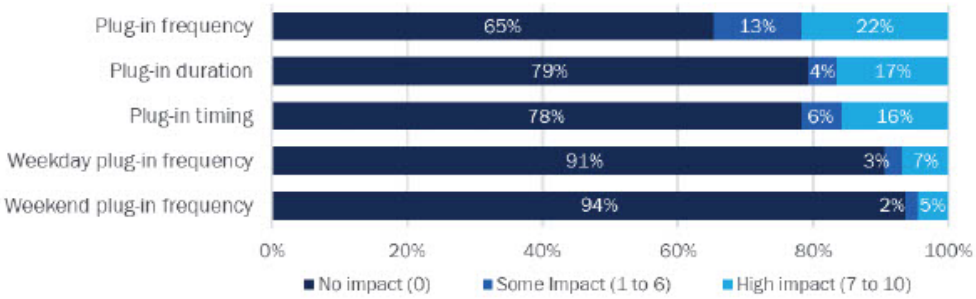


Note: This question was asked only of those who reported owning an EV for at least three months prior to enrolling in the pilot. In addition, "use of charging schedule" was only asked of those who indicated they typically set a charging schedule during the recent event season (n=112).

Most evPulse channel participants who drove an EV prior to enrolling in the pilot reported that the pilot had no impact on their charging behaviors. Among those who did report an impact on charging behaviors, the most often affected behavior was plug-in frequency. Among evPulse channel participants who reported owning an EV for at least three months prior to enrolling in the pilot (75%), approximately one-fifth (22%) reported that enrolling in the pilot was highly

impactful on how often they plugged in their vehicle, while smaller portions of respondents reported high impacts on when they plugged in (17%) or for how long (16%; Figure 9).

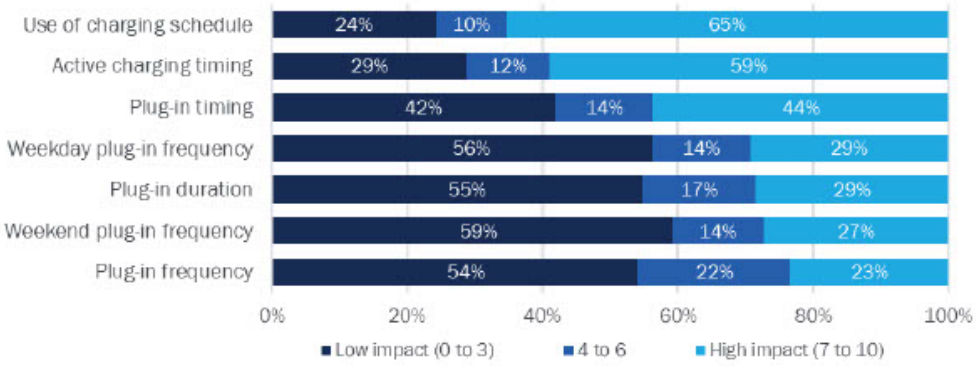
Figure 9. evPulse Participant Changes to Typical Charging Behavior After Enrolling (Multiple Responses Allowed; n=266)



Note: This question was asked only of those who reported owning an EV for at least three months prior to enrolling in the pilot.

Among EVSE channel participants without prior EV charging experience, more reported that the pilot impacted their setting of a charging schedule and the timing of when they charged than other behaviors. For those who did not previously have an EV and established charging habits prior to enrolling in the pilot, we asked respondents to rate the pilot's impact on their charging behaviors. Approximately two-thirds (65%) of EVSE respondents indicated that the pilot was highly impactful on their decision to set a charging schedule (Figure 10).[22] Nearly as many EVSE participants reported the pilot was highly impactful on the timing of their charging (59%), while slightly less than half reported it was highly impactful on when they plugged in their EV (44%).

Figure 10. EVSE Participants' Perceived Impact of Pilot on Home Charging Behavior (n=334)



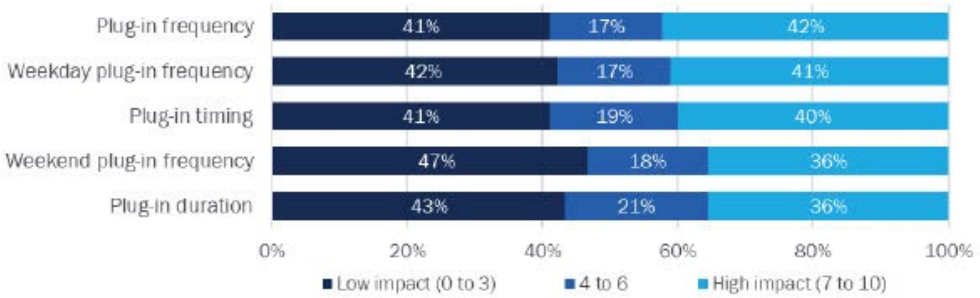
Note: This question was asked only of those who reported owning an EV for less than three months prior to enrolling in the pilot. In addition, "use of charging schedule" was only asked of those who indicated they typically set a charging schedule during the recent event season (n=193).

evPulse channel participants without prior EV experience were split on the impact of the pilot on their charging frequency and timing. Among surveyed evPulse participants who did not drive an EV prior to enrolling in the pilot, approximately two-fifths indicated that the pilot was highly impactful on the frequency with which they plug-in their vehicle (42%), the frequency with which they plug-in during the week (41%), and the timing of when they plug-in (40%;

[22] This was only asked of those who actively set a charging schedule during the Winter 2022/2023 Event Season.

Figure 11). However, similar percentages reported that the pilot had little impact on these behaviors as well as weekend charging frequency and plug-in duration.

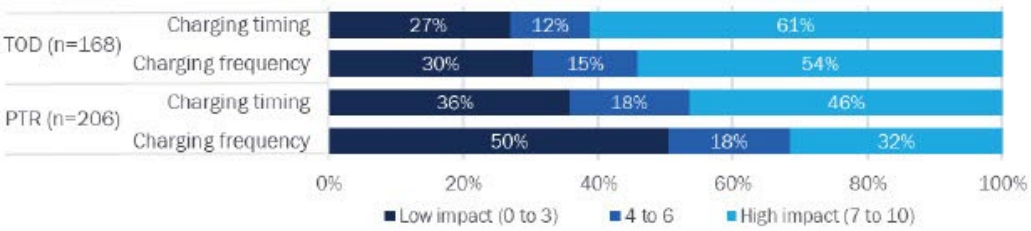
Figure 11. evPulse Participants' Perceived Impact of Pilot on Home Charging Behavior (n=90)



Note: This question was asked only of those who reported owning an EV for less than three months prior to enrolling in the pilot.

Participants enrolled in PGE's TOD rate and PTR offerings acknowledged the influence of those offerings on their charging behavior prior to enrolling in the Residential Charging Pilot. We asked Residential Charging Pilot participants who were also enrolled in PGE's TOD or PTR offerings to rate the degree to which those offerings affected their EV charging behavior prior to enrolling in the Residential Charging Pilot. More than half of those enrolled in PGE's TOD offering suggested it was highly impactful in the timing (61%) and frequency (54%) of their EV charging (Figure 12). Those enrolled in PTR reported somewhat lower impact, with about half (46%) indicating their enrollment in PTR was highly impactful on the timing of their EV charging and about one-third (32%) indicating it highly impacted the frequency.

Figure 12. Impact of TOD and PTR Offerings Prior to Pilot Enrollment on Charging Timing and Frequency



TOD participants were also significantly more likely to typically set a charging schedule during the Winter 2022/2023 Event Season than non-TOD participants (78% versus 51%). However, both TOD and non-TOD participants reported similar levels of Residential Charging Pilot influence on their tendency to set a charging schedule.

3.5 RESIDENTIAL CHARGING PATTERN ANALYSIS

As part of the charging pattern analysis, we explored overall charging load, charging load patterns by day of the week as well as hours of the day under managed and unmanaged scenarios. We also explored differences in charging patterns by participant subgroups of interest, namely by EV type (i.e., BEV vs. PHEV) and TOD rate plan enrollment status. While our analysis reflects the current state of EV charging and driving, it is important to keep in mind the following results from the participant survey:

- While 72% of participating households also own an ICE vehicle, a majority of participants (86%) report using their EV for at least half of weekly driving and another 39% rely on their EV for 90% of typical weekly driving. As EVs increase in presence and replace ICE vehicles as the second vehicle in the household, EV charging needs and patterns may change.
- The charging pattern analysis only includes at-home charging of the participating EVs and does not include charging load from other charging sources such as workplace and public charging locations. According to the participant survey, about two-thirds (64%) of participants charge their EVs exclusively at home while just over one-fifth (21%) use public charging stations and one-tenth (10%) use workplace charging. The evPulse charging data contained data on charging at home and away from home. Our analysis revealed that between 18% and 24% of charging load consumption occurred away from home, depending on the event season. Charging away from home is not managed as part of the Residential Charging Pilot. As EV adoption grows and expands to more customers who are unable to charge at home, charging at public and other locations will be important to monitor.

3.5.1 OVERALL CHARGING LOAD

An average Tesla participating in the evPulse channel uses considerably more electricity than the average participating EVSE vehicle. Depending on the event season, an average vehicle participating in the EVSE channel uses between 6.35 kWh and 7.25 kWh per day, which over the course of an average week amounts to between 44.45 kWh and 50.72 kWh in energy consumed (Table 12). Depending on the season, the average evPulse participant requires between 8.71 kWh and 9.34 kWh to charge per day and 60.97 kWh and 65.36 kW per week. The difference by channel is due, in part, to the presence of PHEVs in the EVSE channel. Between 27% and 32% of the EVSE channel participants (depending on the event season) were PHEVs, which had lower average charging consumption than the BEVs (between 8% and 20% lower). Still, the average BEV enrolled in the EVSE channel had lower consumption than the average Tesla enrolled in the evPulse channel (between 18% and 25% lower depending on the season). Should the vehicle mix in the Residential Charging Pilot change toward a higher proportion of BEVs, the load shifting impacts may shift as well.

The amount of energy needed to charge participating EVs varies slightly across seasons for both the EVSE and evPulse vehicles. Consumption was lower during the Summer 2022 Event Season than either of the winter seasons, likely due to warmer weather and thus higher battery efficiency from not needing to heat the vehicle. But we also found differences in consumption between the two winter event seasons, with greater consumption during the Winter 2022/2023 Event Season than the 2021/2022 Winter Event Season. Because the participant mix is different from season to season, further exploration would be needed to understand the exact causes of seasonal differences in energy consumption. Such exploration could include isolating participants enrolled in the Residential Charging Pilot over the course of all three seasons and comparing their charging load across the seasons. Understanding the causes of seasonal and annual differences in charging will allow PGE to better plan EV charging load moving forward.

Table 12. Average Daily and Weekly Consumption per Vehicle/Charger per EV Type and Season

Group/Season	Number of Vehicles/ Chargers	Average Consumption per Vehicle/Charger per Day (kWh)	Average Consumption per Vehicle/Charger per Week (kWh)
Winter 2021/2022			
EVSE	548	6.73	47.11
BEV	372	7.15	50.05
PHEV	175	5.87	41.06
evPulse	491	8.76	61.32
Summer 2022			
EVSE	924	6.35	44.45
BEV	620	6.51	45.55
PHEV	264	5.94	41.61
evPulse	475	8.71	60.97
Winter 2022/2023			
EVSE	1,267	7.25	50.72
BEV	835	7.57	53.02
PHEV	361	6.30	44.07
evPulse	1,248	9.34	65.36

Note: Excludes evPulse charging away from home. PTR event days are excluded from the analysis.

Participants enrolled in the TOD pricing plan have higher home charging load than non-TOD participants. For both the EVSE and evPulse channels and across all three seasons, TOD enrolled participants used more electricity to charge than non-TOD participants (between 6% and 17% more depending on channel and season) (Table 13). Customers with greater at home charging needs may recognize the savings that participation in TOD would bring and are more likely to sign up for the rate.

Table 13. Average Daily Consumption per Vehicle/Charger by TOD Pricing Plan Enrollment Status

Group/Season	Non-TOD		TOD	
	Number of Vehicles/ Chargers	Average Consumption per Vehicle/Charger per Day (kWh)	Number of Vehicles/ Chargers	Average Consumption per Vehicle/Charger per Day (kWh)
Winter 2021/2022				
EVSE	456	6.64	92	7.18
evPulse	281	8.20	210	9.56
Summer 2022				
EVSE	617	6.19	307	6.75
evPulse	264	8.23	211	9.30
Winter 2022/2023				
EVSE	746	6.91	521	7.77
evPulse	669	9.08	579	9.64

Note: Excludes evPulse charging away from home. PTR event days are excluded from the analysis.

3.5.2 UNMANAGED CHARGING PATTERNS

The Residential Charging Pilot assigned a portion of EVSE channel participants to a control group (Group A), which allowed us to explore EV charging patterns in an unmanaged environment. Exploration of unmanaged charging patterns allows us to better understand the amount of charging load available for reduction during event hours as well as the implications of shifting load to non-event hours, which can inadvertently create additional peaks. The presence of the TOD rate also has the potential to alter participant load given price signals.

Overall, customers conduct between 69% and 71% of their charging on weekdays, depending on the event season. Customers conduct their remaining charging on the weekend, nearly evenly between Saturdays and Sundays. Unmanaged charging varies over the course of the week, with Mondays emerging as the day with the least charging occurring (Figure 13). Charging over the course of other weekdays varies somewhat, but with no observable pattern. Charging patterns are consistent season-over-season by day of the week. Such consistency of the overall charging patterns by the day of the week suggests that the impacts from the managed charging interventions could be consistent as well across weekdays. That said, with Monday having slightly lower charging volume, PGE should be mindful of the possible load impact differences on that day.

Figure 13. Control Group (Group A) Charging Patterns by Day of the Week and Event Season

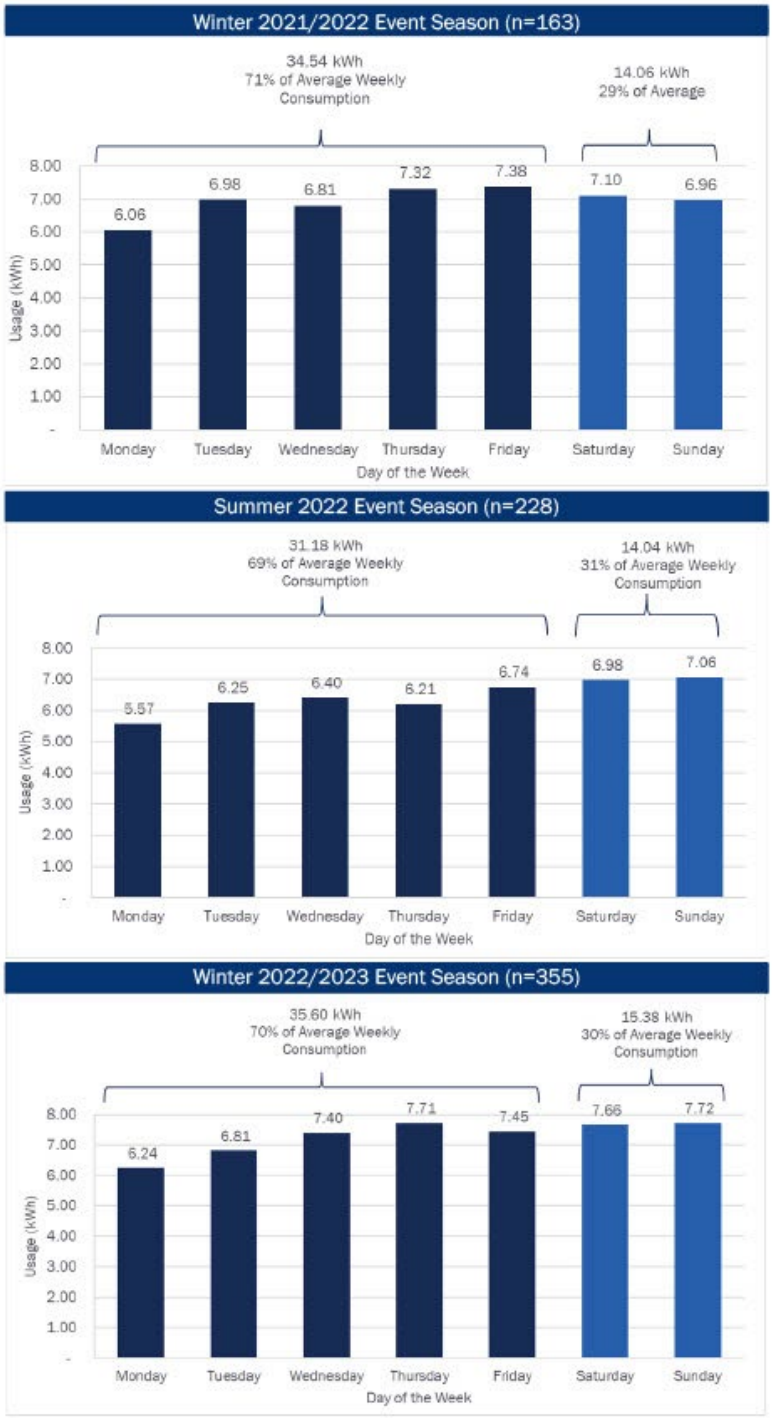


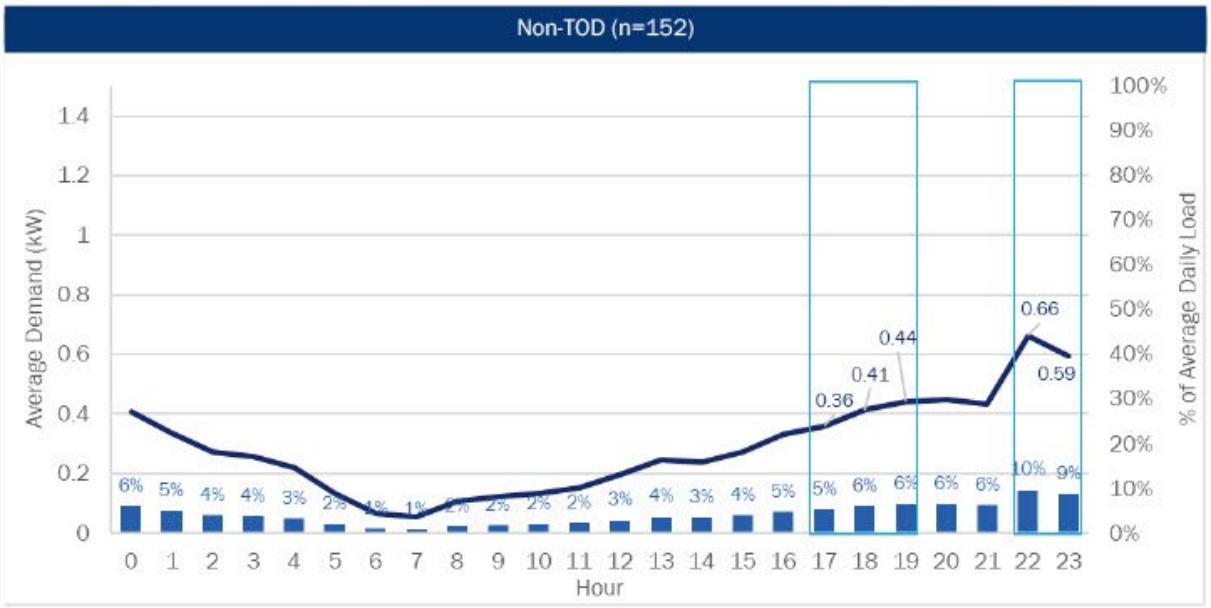
Figure 14, Figure 15, and Figure 16 provide average hourly weekday load shapes for Group A EVSE channel participants for each of the three seasons. We present load shapes for TOD and non-TOD enrollees separately. The TOD population sizes in the Winter 2021/2022 and Summer 2022 Event Seasons are small and the load shapes, as such, should be treated with caution. The figures highlight the two event windows used as part of the Residential Charging Pilot.

Across all seasons, less than one-fifth of all unmanaged non-TOD charging load occurs between the peak hours of 5:00 p.m.–8:00 p.m., the Group B event window. Hourly load during those hours varies from 0.30 kW to 0.47 kW depending on the hour and Event Season. Hourly load is the lowest at 5:00 p.m. and increases steadily during the early evening hours. For all but one hour during the three event seasons, there was not enough unmanaged charging load from 5:00 p.m. to 8:00 p.m. to meet the Residential Charging Pilot's impact planning assumption of 0.45 kW per vehicle/charger.

The TOD rate is effective at shifting load during peak hours. The hourly charging load of Group A TOD enrollees does not exceed 0.19 kW during the Group B event window of 5:00 p.m.–8:00 p.m., and is considerably lower than that of non-TOD participants. Because of the overlap with the TOD On-peak period, the pilot assigned TOD enrollees in the EVSE channel to Group C, which stops EV charging from 10:00 p.m.–11:59 p.m.

The Group C event window of 10:00 p.m.–11:59 p.m. has more load shift potential than the Group B window for both Group A non-TOD and TOD enrollees. Non-TOD charging load gradually increases throughout the evening before more sharply increasing at 10:00 p.m. The average hourly charging load during the Group C window ranges from 0.59 kW to 0.67 kW, depending on the season. It is likely that customers have programmed their chargers to begin charging later at night, but it is unclear why since these customers are not enrolled in TOD. Unsurprisingly, TOD customers show an even greater increase in their charging load beginning at 9:00 p.m., when peak rates end. The charging load of TOD enrollees during the Group C event window ranges from 1.04 kW to 1.4 kW, depending on the hour and the season.

Figure 14. Average Hourly Demand of Control Group (Group A) in Winter 2021/2022 Event Season



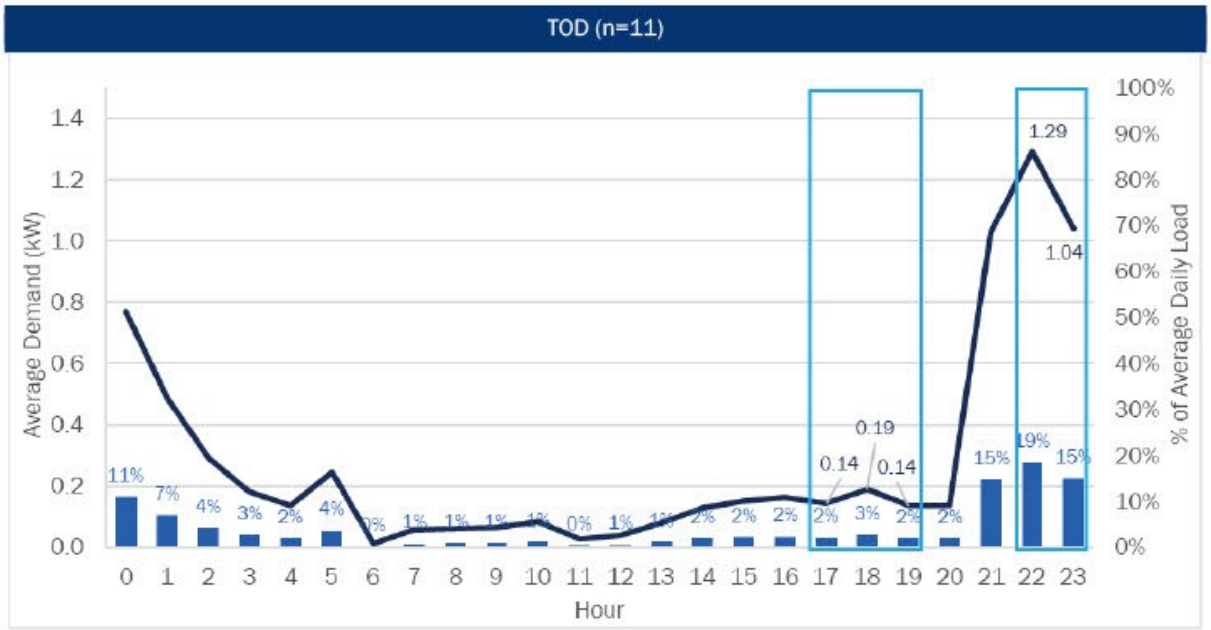


Figure 15. Average Hourly Demand of Control Group (Group A) in Summer 2022 Event Season

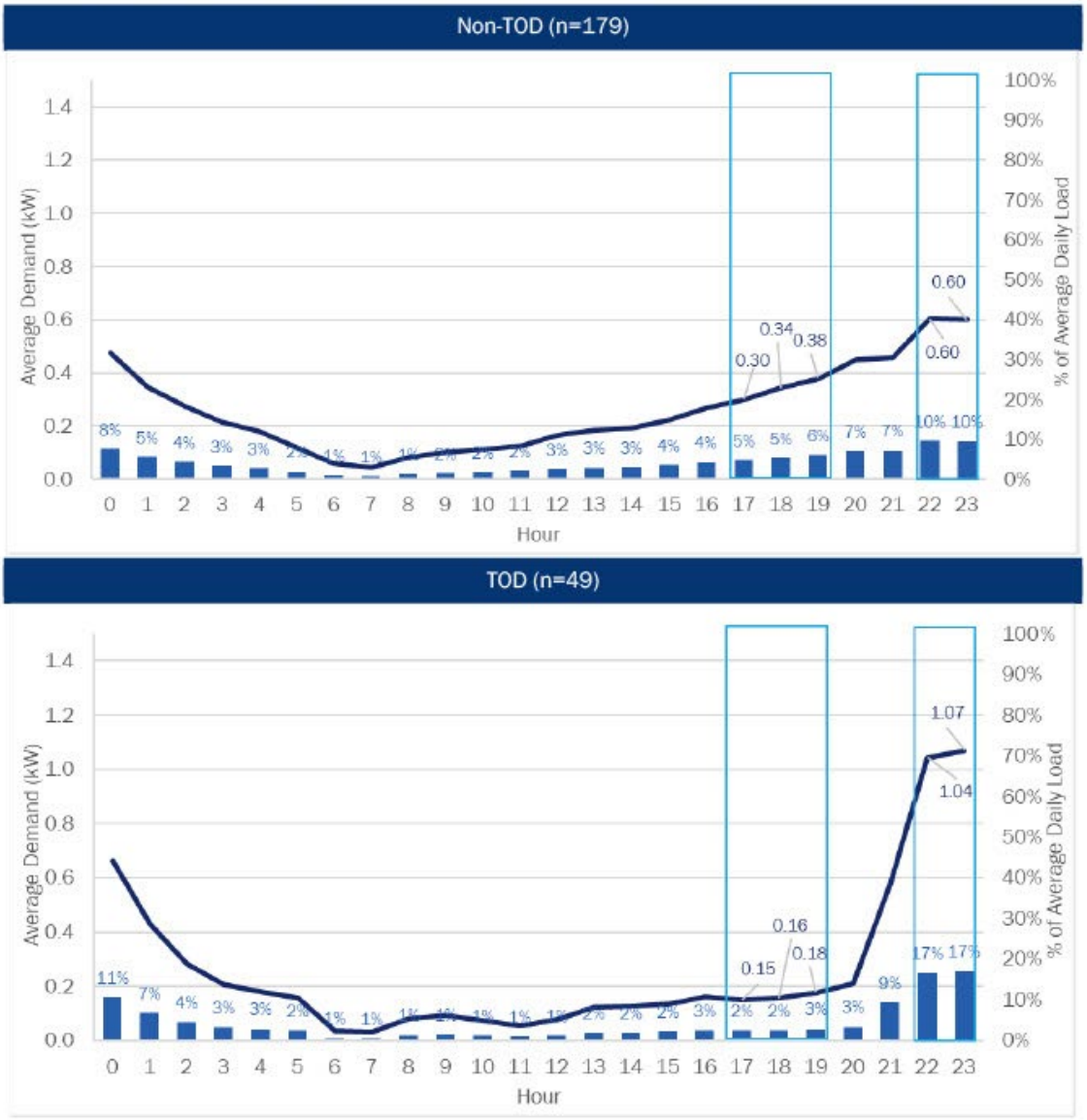
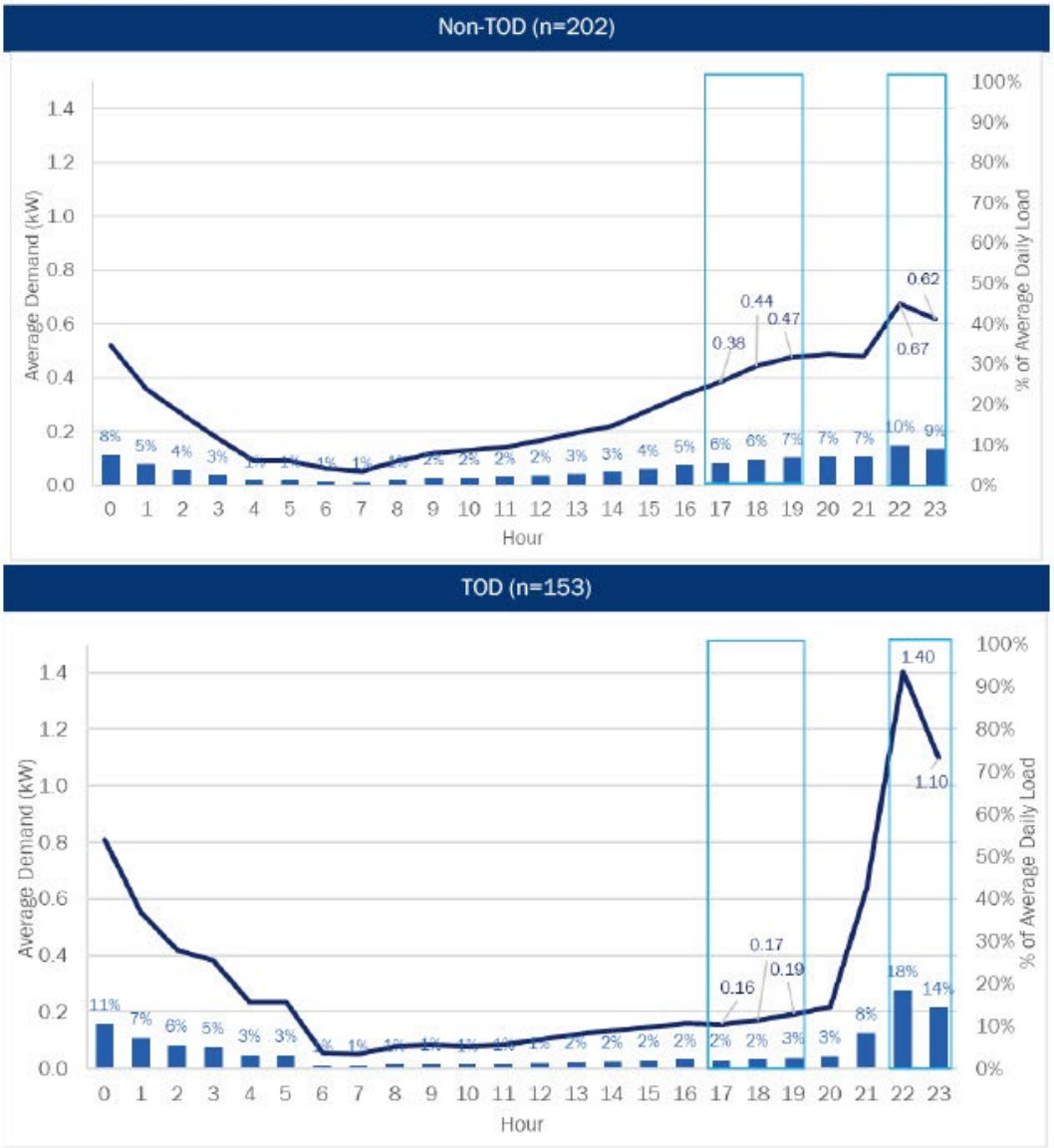


Figure 16. Average Hourly Demand of Control Group (Group A) in Winter 2022/2023 Event Season



The TOD rate shifts charging to late at night and away from peak hours but also has a slight impact on charging during the rest of the day as well. Table 14 provides a summary of the 24-hour charging load during the two pilot event windows (5:00 p.m.–8:00 p.m. and 10:00 p.m.–11:59 p.m.) as well as during the remaining hours of the event day. Both the share of charging as well as average hourly load among TOD participants is half that of non-TOD participants during the TOD peak period (5:00 p.m.–8:00 p.m.),[23] and three-quarters to nearly twice as high between 10:00 p.m. and 11:59 p.m. During all other weekday hours, charging load among non-TOD participants is 2%–6% higher compared to TOD participants.

[23] TOD peak period is 5:00 p.m.–9:00 p.m.

Table 14. Average Percent of Load Consumed by Time Period on Event Days

Season	Time Period	Control Group (Group A) % of Load		Control Group (Group A) Average Hourly (kW)	
		TOD	Non-TOD	TOD	Non-TOD
Winter 2021/2022	*Charger/Vehicle Count*	*11*	*152*	*11*	*152*
	5:00 p.m. – 8:00 p.m.	7%	18%	0.16	0.41
	10:00 p.m. – 11:59 p.m.	34%	18%	1.17	0.63
	All Other Hours	60%	64%	0.22	0.23
Summer 2022	*Charger/Vehicle Count*	*49*	*179*	*49*	*179*
	5:00 p.m. – 8:00 p.m.	8%	16%	0.16	0.34
	10:00 p.m. – 11:59 p.m.	34%	19%	1.06	0.60
	All Other Hours	59%	65%	0.19	0.21
Winter 2022/2023	*Charger/Vehicle Count*	*153*	*202*	*153*	*202*
	5:00 p.m. – 8:00 p.m.	7%	19%	0.17	0.43
	10:00 p.m. – 11:59 p.m.	33%	19%	1.25	0.65
	All Other Hours	60%	62%	0.24	0.22

3.5.3 MANAGED CHARGING PATTERNS

Residential Charging Pilot participant charging patterns changed considerably under managed charging conditions implemented through the pilot. The extent of the change varied depending on the combination of the hours during which participant charging was managed and whether the participant was enrolled in the TOD rate. Figure 17 through Figure 25 show managed charging load shapes for each of the managed charging groups by season and by the presence of the TOD pricing plan. For ease of comparison, we overlaid the managed charging patterns in the figures below with the unmanaged charging patterns from the control group (Group A; light blue dotted line in the figures). Because each group had different managed charging hours, we highlight the relevant event windows in the figures as well.

GROUP B EVSE MANAGED CHARGING PATTERNS

Figure 17, Figure 18, and Figure 19 display the managed charging patterns of non-TOD EVSE channel participants who were assigned to Group B for the three event seasons. Due to the very small number of TOD participants in Group B, we do not present TOD participant load shapes separately.

During the Group B event window (5:00 p.m.–8:00 p.m.), EV charging load was between 0.05 kW–0.11 kW, depending on the hour and event season. At any given hour during the event window, charging load did not exceed 2% of the average weekday charging load, and across all hours the load did not exceed 5% of the average weekday charging load. Relative to Group A non-TOD, participants conducted more of their charging in the four hours following the end of the period (8:00 p.m.– 11:59 p.m.) with 8:00 p.m. seeing the highest increase in load. These charging patterns are generally consistent across the three event seasons.

Figure 17. Average Hourly Demand of Group B EVSE Non-TOD Participants (N=154) – Winter 2021/2022

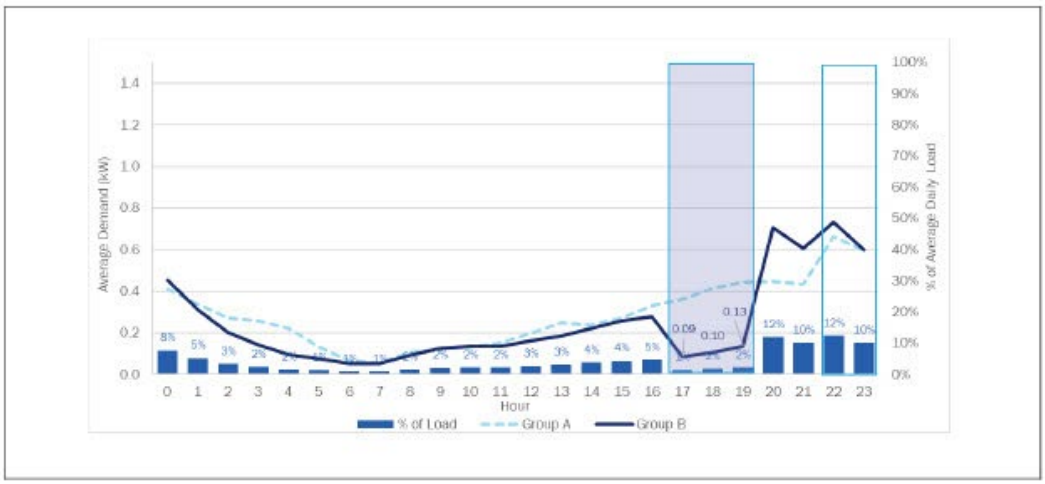


Figure 18. Average Hourly Demand of Group B EVSE Non-TOD Participants (N=229) – Summer 2022

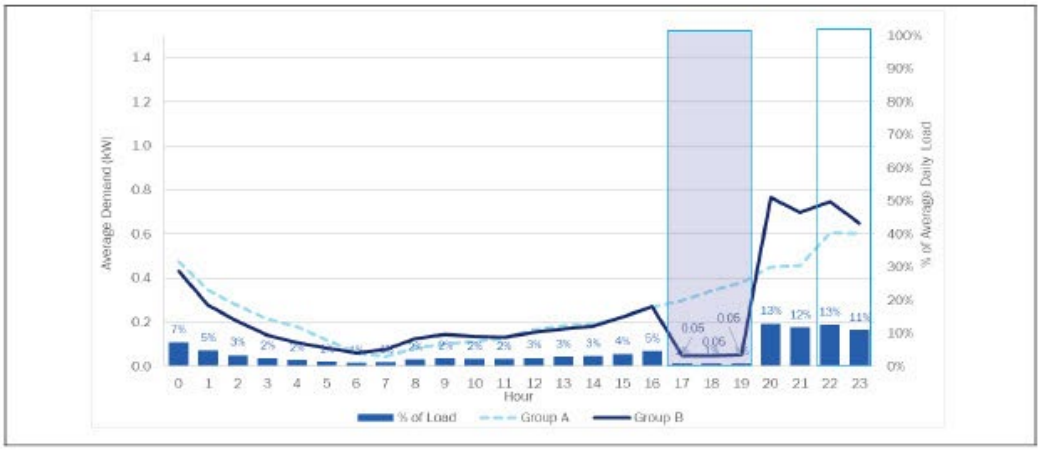
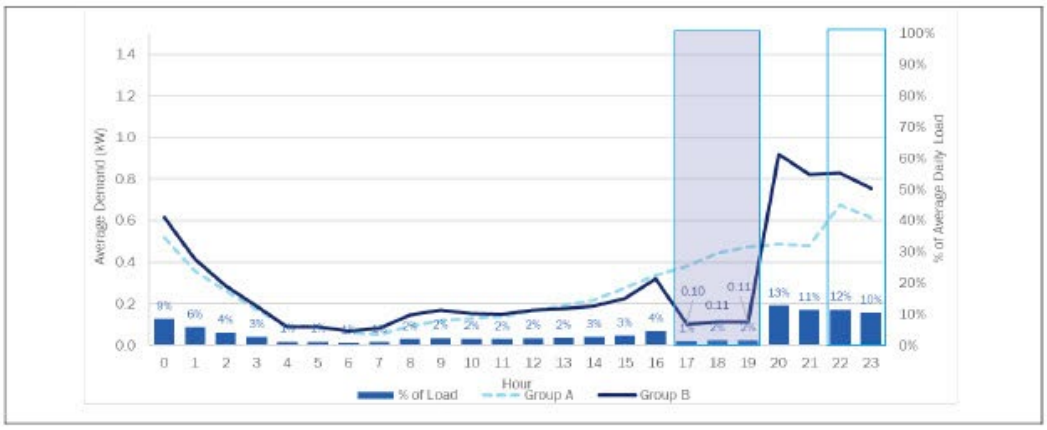


Figure 19. Average Hourly Demand of Group B EVSE Non-TOD Participants (N=303) – Winter 2022/2023



GROUP C MANAGED CHARGING PATTERNS

Figure 20, Figure 21, and Figure 22 display the managed charging patterns of TOD and non-TOD EVSE channel participants who were assigned to Group C for the three event seasons.

Managed charging patterns during the Group C event window of 10:00 p.m.–11:59 p.m. were different for non-TOD and TOD enrollees. The absolute kW load during the event hours was considerably higher for Group C TOD participants compared to Group C non-TOD participants. However, relative to Group A TOD, Group C TOD participants appear to have considerably more load reduction than Group C non-TOD participants have relative to Group A non-TOD. For Group C non-TOD participants, charging load decreased from 0.08 kW to 0.18 kW depending on the hour and event season. At any given hour in that period, the load did not exceed 2% of the average weekday charging load, and across all hours the load did not exceed 6% of the average weekday charging load.

Group C TOD participant load ranged from 0.18 kW to 0.40 kW depending on the event hour and the season. The load represented between 4% and 7% of the average weekday charging load at any given event hour and between 6% and 14% of the average weekday charging load across the two event hours. Relative to Group A, both non-TOD and TOD Group C participants conducted more of their charging in the overnight hours. Due to the off-peak period starting at 9:00 p.m., there is a spike in charging during that hour among TOD participants.

Figure 20. Average Hourly Demand of Group C EVSE in Winter 2021/2022

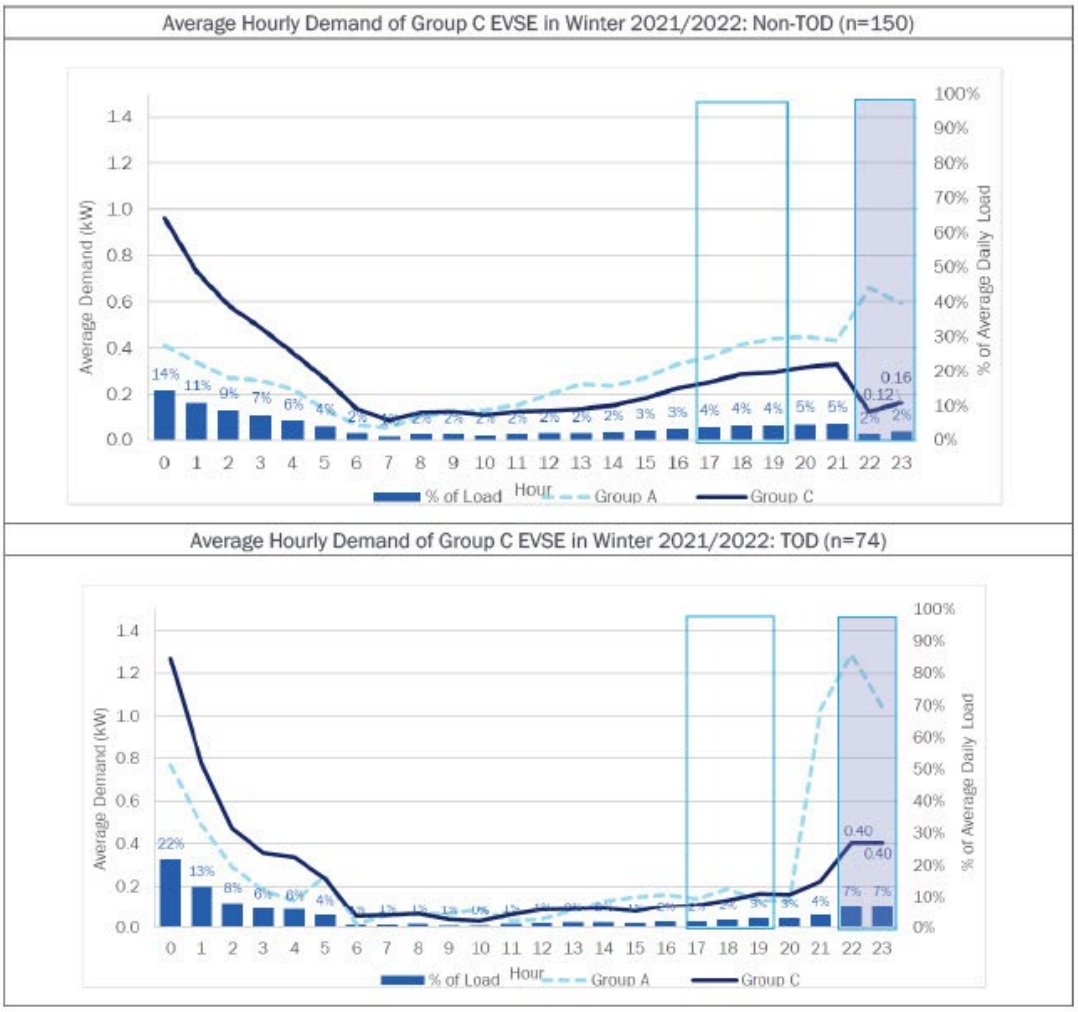


Figure 21. Average Hourly Demand of Group C EVSE in Summer 2022

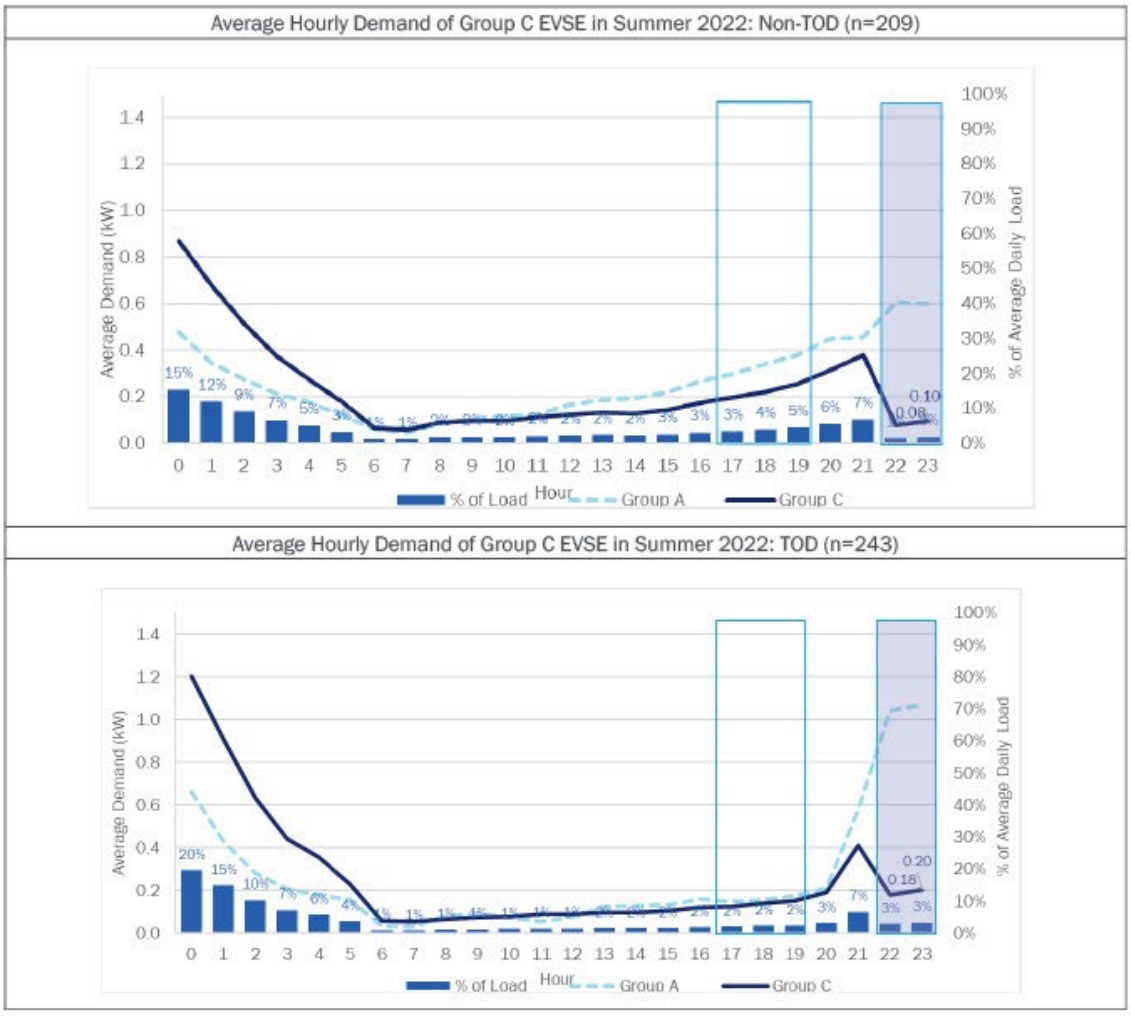
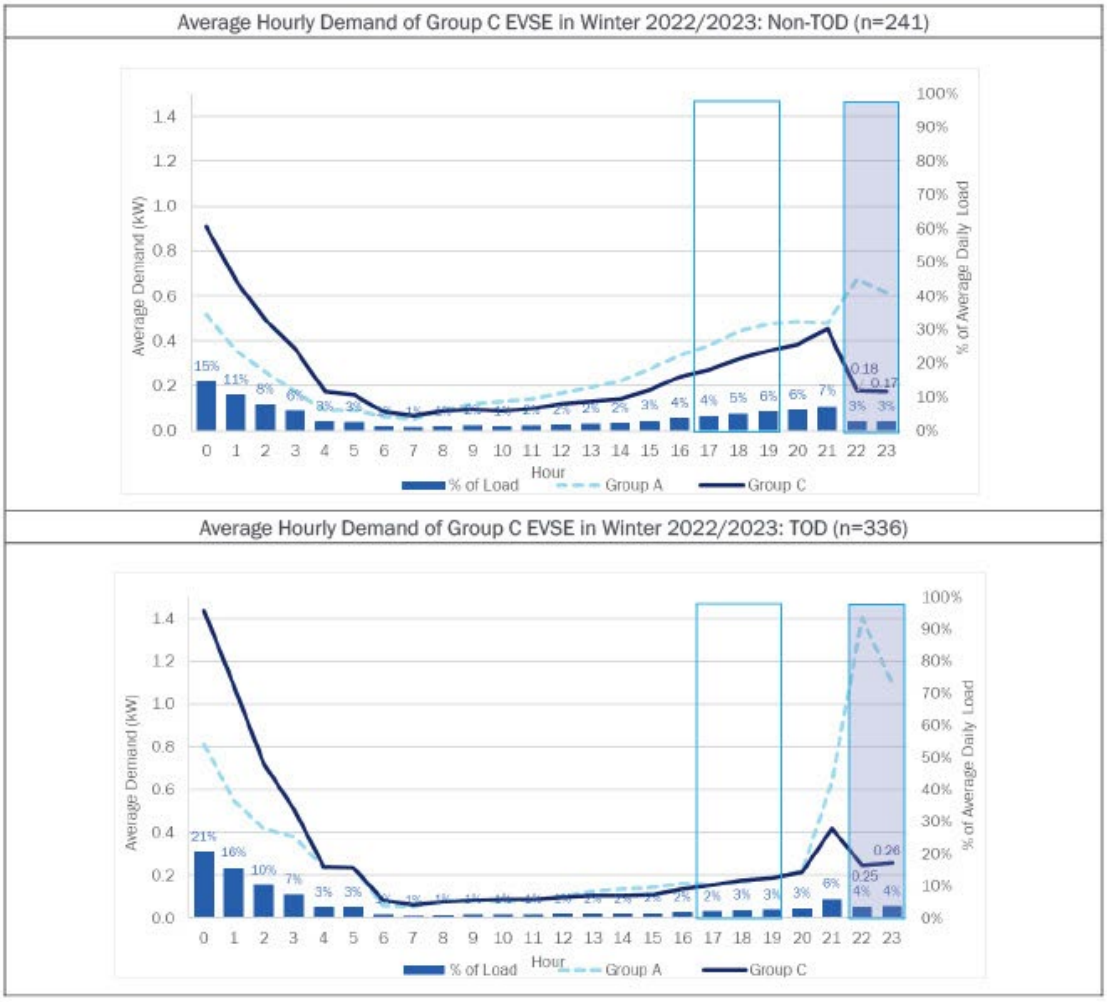


Figure 22. Average Hourly Demand of Group C EVSE in Winter 2022/2023



EVPULSE MANAGED CHARGING PATTERNS

Figure 23, Figure 24, and Figure 25 display the managed charging patterns of the evPulse TOD and non-TOD participants for the three event seasons. While we include the control group (Group A) charging profile in the figures, caution should be used when comparing the two profiles as the evPulse participant population is different both in terms of vehicle types as well as overall charging load.

Both TOD and non-TOD evPulse Group B participants have similar load charging patterns during the Group B event window (5:00 p.m.–8:00 p.m.) with hourly load increasing over the course of the event. During the Summer 2022 and Winter 2022/2023 Event Seasons, evPulse Group B hourly load ranged from 0.07 kW to 0.1 kW, depending on the hour. Average hourly charging load during event hours was higher during the winter 2021/2022 Event Season, ranging from 0.13 kW to 0.18 kW. Relative to Group A, Group B evPulse participants, both TOD and non-TOD, conducted more of their charging load in the hours following the end of the period. Because the TOD peak period runs until 9:00 p.m., the increase in charging load for TOD participants begins an hour later than non-TOD participants.

Figure 23. Average Hourly Demand of evPulse (Group B) in Winter 2021/2022

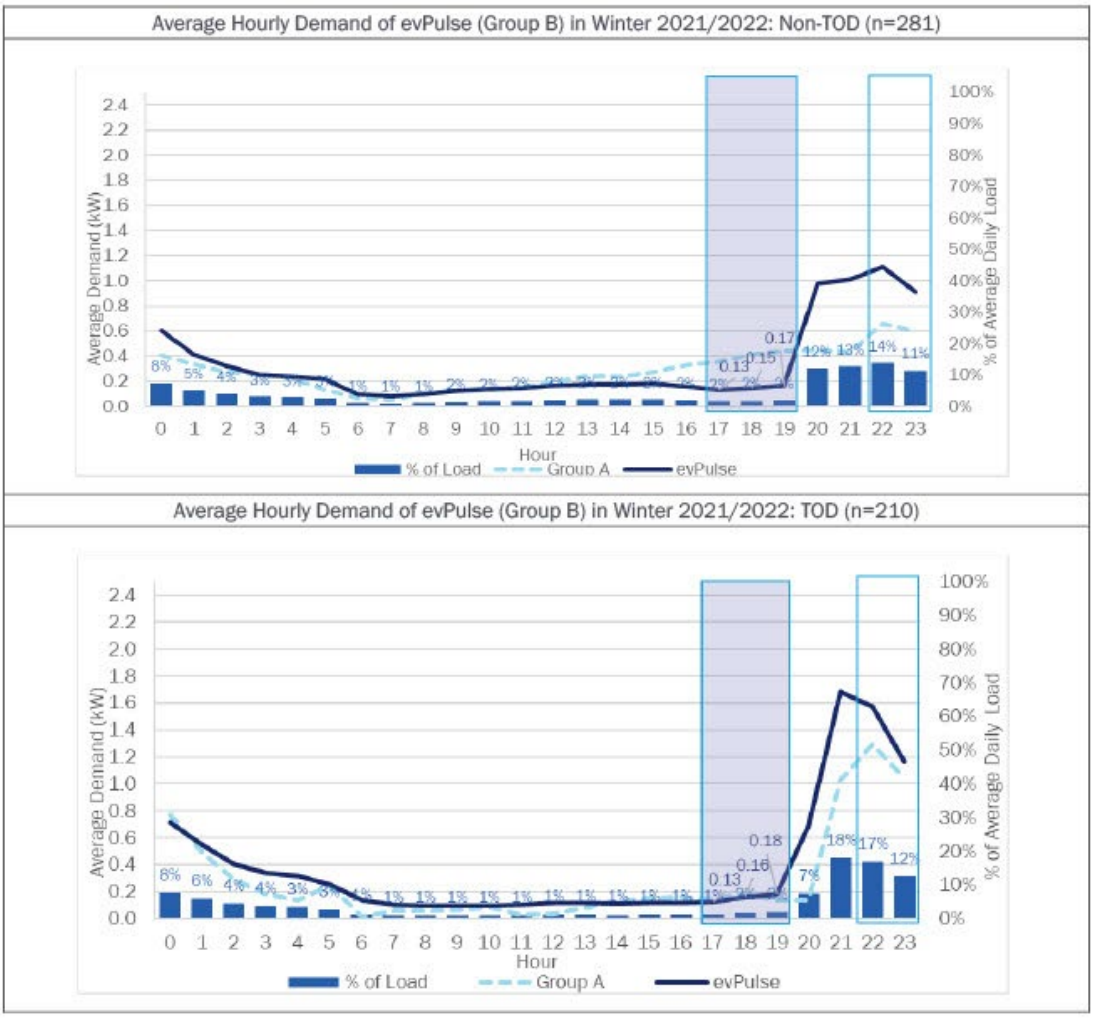


Figure 24. Average Hourly Demand of evPulse (Group B) in Summer 2022

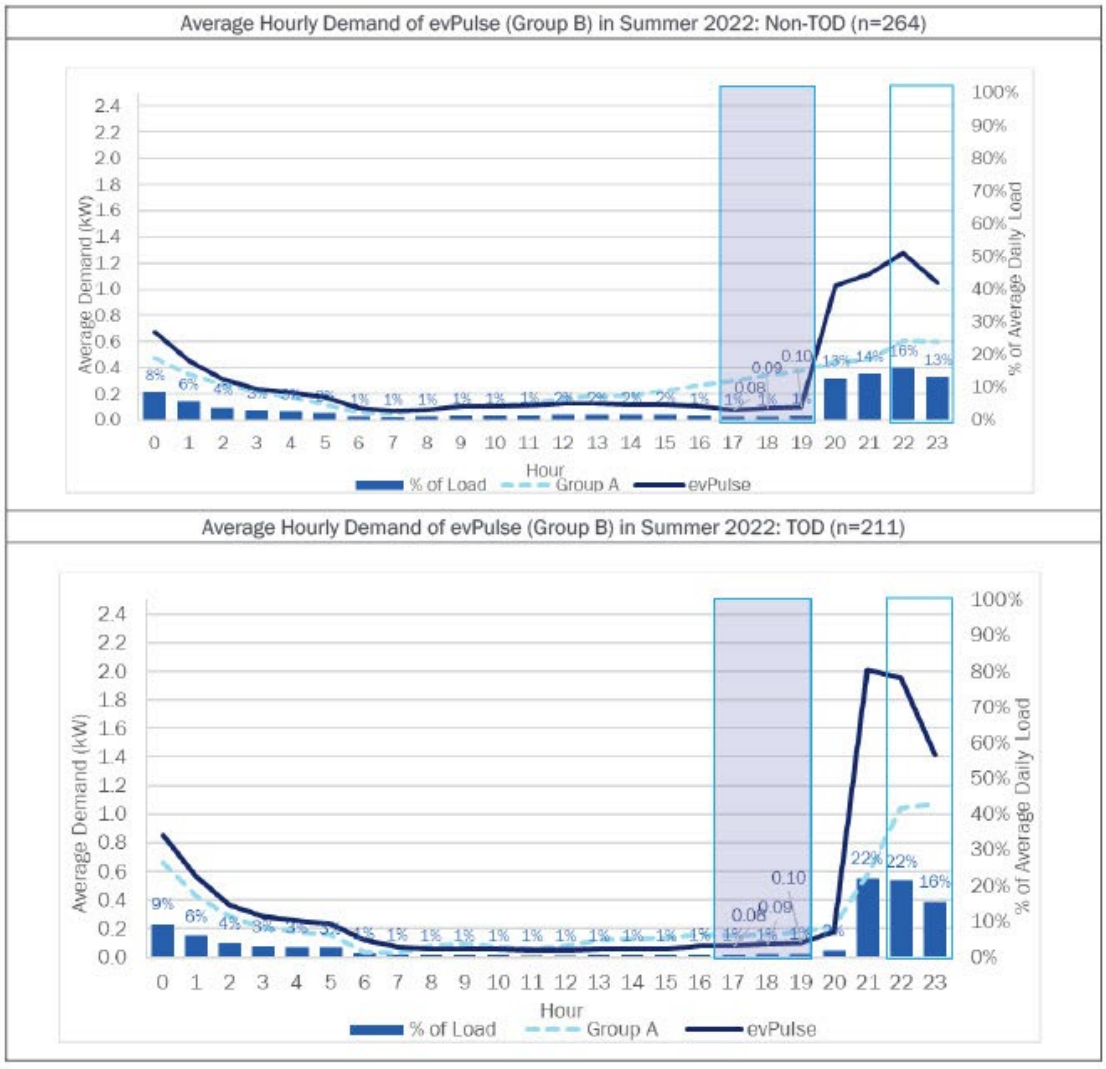
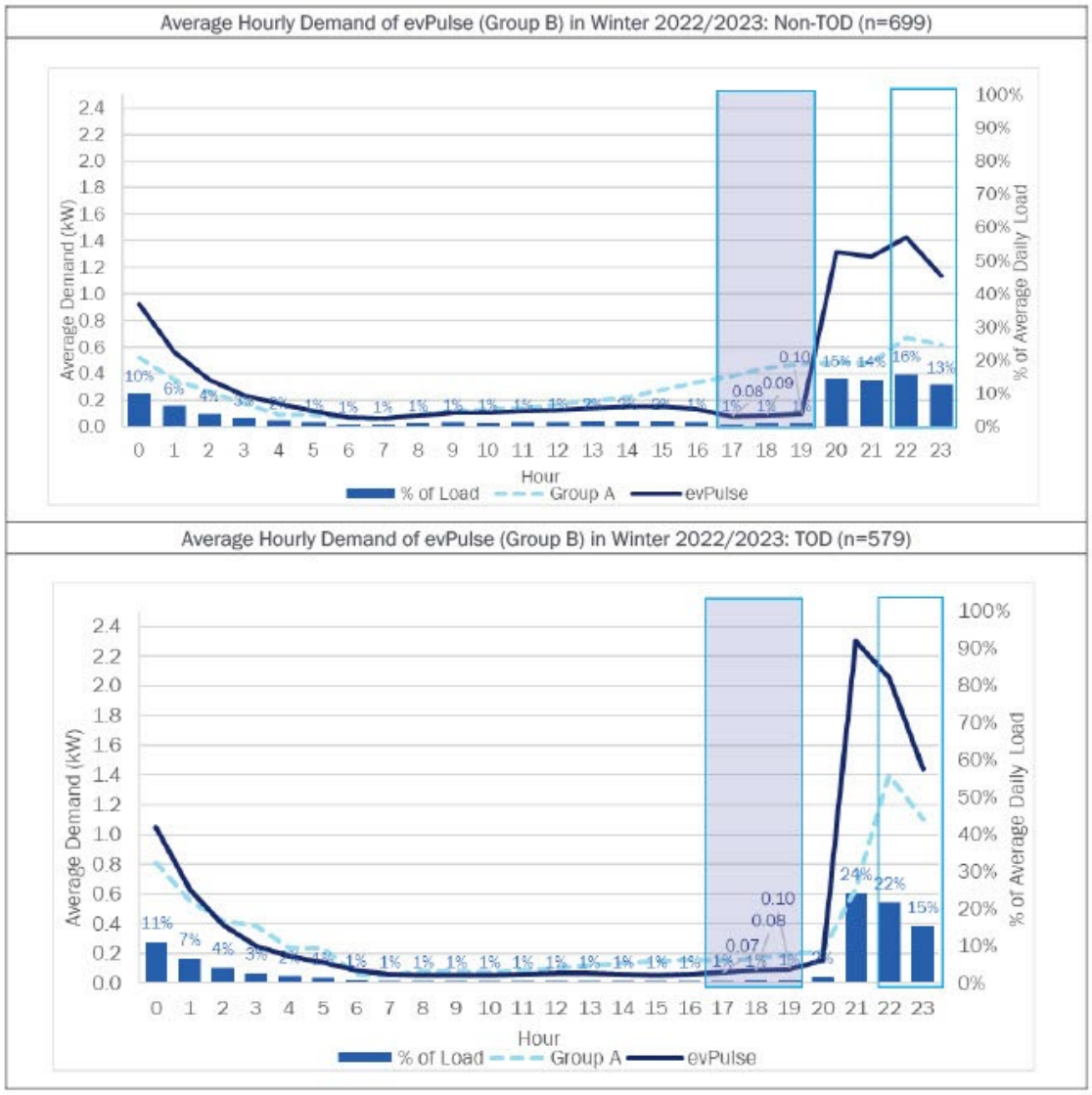


Figure 25. Average Hourly Demand of evPulse (Group B) in Winter 2022/2023



ALL TREATMENT GROUPS MANAGED CHARGING PATTERNS

Table 15 and Table 16 provide a summary of the 24-hour charging load during the two pilot event windows (5:00 p.m. to 8:00 p.m. and 10:00 p.m. to 11:59pm) as well as during the remaining hours of the event day. The tables allow comparison of the three treatment groups and the control group, differentiated by TOD enrollment status where participant population sizes allow. The specific event hours of each treatment group are highlighted in blue.

A comparison of the relative charging load during event hours between the treatment and control groups shows a clear shift in the charging load across all treatment groups. However, charging during event hours did not drop to zero, suggesting some customers opted out or overrode managed charging curtailment (Table 15).

Table 15. Average Percent of Load Consumed by Time Period on Event Days

Season	Time period	TOD			Non-TOD			
		Group A (Control)	Group B (evPulse)	Group C	Group A (Control)	Group B (EVSE)	Group B (evPulse)	Group C
Winter 2021/2022	*Charger/Vehicle Counts*	*11*	*210*	*74*	*152*	*154*	*281*	*150*
	5:00 p.m.–8:00 p.m.	7%	5%	7%	18%	5%	6%	12%
	10:00 p.m.–11:59 p.m.	34%	29%	14%	18%	22%	25%	4%
	All Other Hours	60%	66%	79%	64%	72%	69%	83%
Summer 2022	*Charger/Vehicle Counts*	*49*	*211*	*243*	*179*	*229*	*264*	*209*
	5:00 p.m.–8:00 p.m.	8%	3%	7%	16%	3%	3%	12%
	10:00 p.m.–11:59 p.m.	34%	37%	6%	19%	24%	29%	3%
	All Other Hours	59%	60%	87%	65%	74%	67%	85%
Winter 2022/2023	*Charger/Vehicle Counts*	*153*	*579*	*336*	*202*	*303*	*699*	*241*
	5:00 p.m.–8:00 p.m.	7%	3%	7%	19%	5%	3%	15%
	10:00 p.m.–11:59 p.m.	33%	37%	7%	19%	22%	28%	6%
	All Other Hours	60%	61%	85%	62%	73%	69%	79%

Note: Blue shaded cells are each group's event window. Excludes evPulse away charging and PTR event days. Excludes Group B EVSE TOD participants due to the small count of participants on the rate.

Average hourly charging load during event hours is considerably lower than non-event hours across all cohorts, except TOD Group C participants. The average charging load of TOD Group C participants during Group B event hours of 5:00 p.m.– 8:00 p.m. is lower than during the Group C event window of 10:00 p.m.–11:59 p.m. (0.14 kW to 0.17 kW compared to 0.19 kW to 0.40 kW) (Table 16). Relative to Group A, non-TOD Group C participants have higher charging load during Group B event hours; the average charging demand during peak hours varies across event seasons but is similar to the average demand during all other hours (0.22 kW to 0.32 kW compared to 0.25 kW to 0.29 kW).

Table 16. Average Demand (kW) by Time Period on Event Days per Vehicle/Charger

Season	Time period	TOD			Non-TOD			
		Group A (Control)	Group B (evPulse)	Group C	Group A (Control)	Group B (EVSE)	Group B (evPulse)	Group C
Winter 2021/2022	*Charger/Vehicle Counts*	*11*	*210*	*74*	*152*	*154*	*281*	*150*
	5:00 p.m.–8:00 p.m.	0.16	0.16	0.14	0.41	0.11	0.15	0.28
	10:00 p.m.–11:59 p.m.	1.17	1.37	0.40	0.63	0.67	1.01	0.14
	All Other Hours	0.22	0.32	0.24	0.23	0.23	0.29	0.29
Summer 2022	*Charger/Vehicle Counts*	*49*	*211*	*243*	*179*	*229*	*264*	*209*
	5:00 p.m.–8:00 p.m.	0.16	0.09	0.14	0.34	0.05	0.09	0.22
	10:00 p.m.–11:59 p.m.	1.06	1.68	0.19	0.60	0.70	1.16	0.09
	All Other Hours	0.19	0.29	0.28	0.21	0.23	0.28	0.25
Winter 2022/2023	Charger/Vehicle Counts	153	579	336	202	303	699	241
	5:00 p.m.–8:00 p.m.	0.17	0.08	0.17	0.43	0.11	0.09	0.32
	10:00 p.m.–11:59 p.m.	1.25	1.75	0.25	0.65	0.79	1.28	0.18
	All Other Hours	0.24	0.30	0.31	0.22	0.28	0.33	0.26

Note: Blue shaded cells are each group's event window. Excludes evPulse away charging and PTR event days.

3.6 MANAGED CHARGING IMPACTS

In the following sections, we provide estimated charging load impacts due to the Residential Charging Pilot interventions across three event seasons: Winter 2021/2022, Summer 2022, and Winter 2022/2023. We provide additional details on data-cleaning and analysis methods in Appendix A.

The Residential Charging Pilot reduced an average of 0.37 kW of charging load per event hour per participant during the Winter 2021/2022 Event Season, 0.40 kW during the Summer 2022 Event Season, and 0.49 kW during the Winter 2022/2023 Event Season for EVSE participants. Table 17 presents modeled per-vehicle and total load impacts across the three event seasons. Due to the increasing participating population of EVs as well as growing per-vehicle impacts season-to-season, the Residential Charging Pilot reduced a total of 142 kW during event hours in the Winter 2021/2022 Event Season, 284 kW in the Summer 2022 Event Season, and 489 kW in the Winter 2022/2023 Event Season for EVSE participants.

Table 17. Average EVSE Event Demand Impacts per Charger by Event Season

Season	Total Vehicles/Chargers Enrolled at the End of the Event Season	Average Hourly Load Impact per Vehicle/Charger (kW)	Total Hourly Load Impact (kW)
Winter 2021/2022	379	0.37	142
Summer 2022	710	0.40	284
Winter 2022/2023	1,005	0.49	489

Note: Excludes evPulse channel participants and PTR event days.

The evaluation team chose not to include evPulse in the estimation of pilot impacts due to the lack of equivalency with the baseline charging provided by the control group, Group A. The control group was constructed entirely from EVSE channel participants and differs considerably from evPulse participants on several key characteristics. In addition to the differences identified in the charging pattern analysis presented above, we provide additional details on our equivalency analysis and estimates of evPulse impacts using a simple difference methodology in Appendix A. If the evPulse impacts from the simple difference calculation were included in our estimation of pilot impacts, the average hourly event impact per vehicle/charger would be 0.29, 0.32 and 0.34 for the Winter 2021/2022, Summer 2023 and Winter 2022/2023 season, respectively. The total hourly load impacts for the pilot would be 243 kW for the Winter 2021/2022 season, 375 kW for the Summer 2022 season, and 771 kW for the Winter 2022/2023 season.

- The size of the load impacts varied by treatment group, with Group C, whose event hours were later in the evening when there was more charging load to reduce, consistently achieving larger impacts. Group C impacts were nearly double Group B EVSE impacts, reaching as much as 0.62 kW per-charger compared to 0.34 kW during the Winter 2022/2023 Event Season. These differences in load impacts by participant group are not surprising given the findings from the charging pattern analysis that showed greater charging load for Group A during the Group C event hours compared to Group B hours. Table 18 provides the average baseline load (Group A charging load) for each treatment group. The baseline load during Group C event hours was double or close to double that of Group B EVSE across the three event seasons.
- Load impacts represented as a percentage of baseline load are relatively similar between the Groups B EVSE and C, though there is variation by season. During the Winter 2021/2022 Event Season, Group B's percent load impacts were slightly lower at 72% compared to Group C's percent load impacts of 76% (Table 18). During the Summer 2022 Event Season as well as Winter 2022/2023 Event Season, Group B's percent load impacts were higher than Group C's (84% vs. 80% and 77% vs. 72%, respectively). The percent load impacts of both winter seasons were less than the summer season.
- Across all three event seasons, Group C had nearly triple the total load impacts of Group B EVSE. The performance difference is due to the larger number of EVSE participants assigned to Group C and the greater amount of baseline load during the Group C event window, which allowed higher per charger load reduction (Table 18).
- The pilot load impacts of Group C TOD participants were nearly double that of non-TOD Group C participants. For the Winter 2022/2023 Event Season, we had enough participants to estimate separate load impacts by TOD enrollment status for Group C. TOD participants reduced an average of 0.76 kW of charging load compared to 0.41 kW for non-TOD participants during event hours (Table 18). Group A TOD enrollees had more charging load in the evenings, resulting in greater baseline load compared to Group A non-TOD. Load impacts as a percentage of baseline load are similar for TOD and non-TOD.

Table 18. Average EVSE Channel Event Demand Impacts per Charger and Group by Event Season

Season	Group	Total Vehicles/ Chargers Enrolled at the End of the Event Season	Average Hourly Baseline Load Per-Vehicle/ Charger (kW)	Average Hourly Load Impact per Vehicle/Charger (kW)	% of Load Impact	Total Hourly Load Impact (kW)
Winter 2021/2022	Group B (5:00 p.m.–8:00 p.m.)	157	0.38	0.27	72%	43
	Group C (10:00 p.m.–11:59 p.m.)	222	0.63	0.48	76%	107
	Total	379	0.50	0.37	74%	142
Summer 2022	Group B (5:00 p.m.–8:00 p.m.)	248	0.32	0.27	84%	67
	Group C (10:00 p.m.–11:59 p.m.)	462	0.64	0.51	80%	233
	Total	710	0.50	0.40	81%	284
Winter 2022/2023	Group B (5:00 p.m.–8:00 p.m.)	373	0.44	0.34	77%	127
	Group C (10:00 p.m.–11:59 p.m.)	632	0.86	0.62	72%	390
	Group C – TOD	376	1.06	0.76	72%	285
	Group C – Non-TOD	256	0.58	0.41	71%	105
	Total	1,005	0.66	0.49	73%	489

Hourly load impacts over the course of the event windows are relatively consistent with differences due to changes in the baseline load. Among Group B EVSE participants, baseline load increased slightly during the event window resulting in slightly greater average load impacts after the first hour. Group C's load impacts are lower during the second hour of the event window during the winter seasons primarily due to lower baseline load during the second hour (Table 19).

Table 19. Average EVSE Channel Demand Impact per Charger by Group, Event Season, and Event Hour

Group	Winter 2021/2022			Summer 2022			Winter 2022/2023		
	Average Hourly Baseline Load Per-Vehicle/ Charger (kW)	Average Hourly Event Impact per Vehicle/ Charger (kW)	% Impact	Average Hourly Baseline Load Per-Vehicle/ Charger (kW)	Average Hourly Event Impact per Vehicle/ Charger (kW)	% Impact	Average Hourly Baseline Load Per-Vehicle/ Charger (kW)	Average Hourly Event Impact per Vehicle/ Charger (kW)	% Impact
Group B (EVSE)									
Hour 1	0.34	0.25	74%	0.29	0.23	82%	0.40	0.30	76%
Hour 2	0.39	0.29	75%	0.32	0.27	85%	0.45	0.35	76%
Hour 3	0.41	0.28	68%	0.36	0.31	86%	0.48	0.37	77%
Average	**0.38**	**0.27**	**72%**	**0.32**	**0.27**	**84%**	**0.44**	**0.34**	**77%**
Group C (All)									
Hour 1	0.67	0.55	81%	0.63	0.51	80%	0.95	0.71	75%
Hour 2	0.59	0.41	70%	0.64	0.50	79%	0.77	0.53	68%
Average	**0.63**	**0.48**	**76%**	**0.64**	**0.51**	**80%**	**0.86**	**0.62**	**72%**
Group C – Non-TOD									
Hour 1	-	-	-	-	-	-	0.61	0.44	72%
Hour 2	-	-	-	-	-	-	0.55	0.38	70%
Average							**0.58**	**0.41**	**71%**
Group C – TOD									
Hour 1	-	-	-	-	-	-	1.18	0.89	75%
Hour 2	-	-	-	-	-	-	0.93	0.63	68%
Average	-	-	-	-	-	-	**1.05**	**0.76**	**72%**

Note: Group C All is the weighted average of Group C TOD and Non-TOD participants in the Winter 2022/2023 season.

The Residential Charging Pilot came short of PGE's planning assumption of 0.45 kW for the Winter 2021/2022 and Summer 2022 Event Seasons, reaching 83% and 89% of the goal, respectively. The pilot exceeded the goal for the Winter 2022/2023 Event Season. Across all event seasons, Group C consistently exceeded the planning goal, while Group B's load impacts were considerably lower than the planning assumption (Table 20). Group B's underperformance is a function of a much lower baseline load. Across all seasons, the average baseline load for Group B participants was lower than the planning load impact assumption. The increased performance of Group C across the seasons is due primarily to an increase in the baseline load, particularly during the Winter 2022/2023 Event Season.

Table 20. Average EVSE Channel Event Baseline and Demand Impacts per Charger and Group by Event Season

Season	Group	Average Hourly Baseline Load per Vehicle/Charger (kW)	Average Hourly Load Impact per Vehicle/Charger (kW)	Planning Assumption (kW)	Percent of Planning Assumption Achieved
Winter 2021/2022	Group B (5:00 p.m.–8:00 p.m.)	0.38	0.27	0.45	61%
	Group C (10:00 p.m.–11:59 p.m.)	0.63	0.48		107%
	Total	0.50	0.37		83%
Summer 2022	Group B (5:00 p.m.–8:00 p.m.)	0.32	0.27		60%
	Group C (10:00 p.m.– 11:59 p.m.)	0.64	0.51		112%
	Total	0.50	0.40		89%
Winter 2022/2023	Group B (5:00 p.m.–8:00 p.m.)	0.44	0.34		75%
	Group C (10:00 p.m.– 11:59 p.m.)	0.86	0.62		137%
	Group C – TOD	1.07	0.76		168%
	Group C – Non-TOD	0.58	0.41		92%
	Total	0.66	0.49		108%

3.7 EVENT OPT-OUTS

Our load impact analysis showed that average hourly charging load shift is highly dependent on the amount of baseline load that is available to shift. While the pilot shifted a large amount of load relative to the baseline for all groups, a small percentage of charging still took place. In this section, we further explore the frequency of customers opting out of events by charging during their assigned event window.[24]

Based on analysis of charging interval data, Group C had the highest average percent of participants opt out per event while Group B EVSE had the lowest across the three seasons. To better understand opt-out behaviors, we calculated, for each event day, the share of participants who charged during at least a portion of the event hours. Table 21 shows the minimum, maximum, and average opt-out rates. Opt-out rates vary by season and group. On average, between 2% and 19% of participants opted-out of events by charging their EVs. The maximum opt-out rate occurred on December 31, 2021, when one-third of Group C participants charged during their 10:00 p.m.–11:59 p.m. event window. On average, Group C had the highest average and maximum opt-out rates. Group B EVSE had the lowest average opt-out rates whereas Group B evPulse had the lowest maximum opt-out rates. During the Summer 2022 and Winter 2022/2023 Event Seasons, Group B evPulse participants did not have a single event day without an opt-out.

Table 21. Average Percent of Participants that Charge During an Event

Season/Group	Maximum Percentage of Participants that Charge During an Event	Average Percentage of Participants Charging During an Event	Minimum Percentage of Participants Charging During an Event
Winter 2021/2022			
Group B EVSE	23%	7%	0%
Group B evPulse	16%	12%	0%
Group C	33%	12%	0%
Overall	33%	10%	0%
Summer 2022			
Group B EVSE	15%	2%	0%
Group B evPulse	14%	8%	5%
Group C	27%	14%	0%
Overall	27%	8%	0%
Winter 2022/2023			
Group B EVSE	24%	4%	0%
Group B evPulse	11%	6%	3%
Group C	29%	19%	0%
Overall	29%	10%	0%

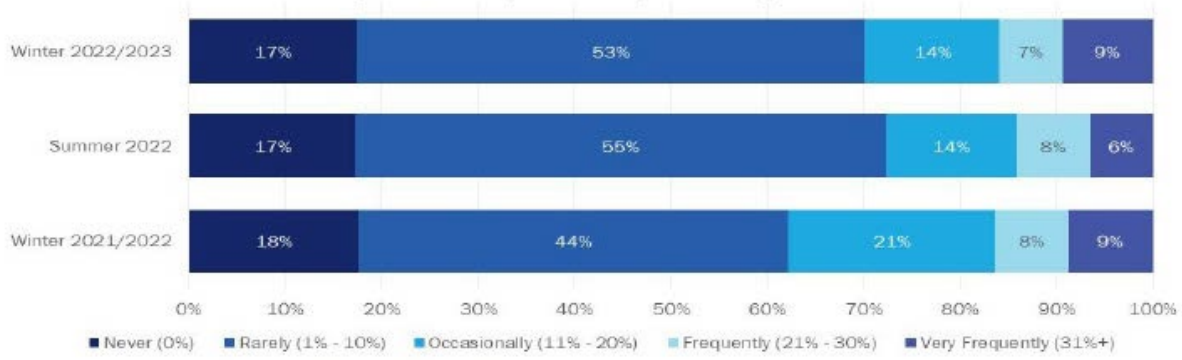
Note: Charging during an event is defined as having a greater than 0 usage for at least one hour during the event hours. Excludes evPulse away charging and PTR event days.

Not all participants opt out of the events. A majority never or rarely opted out while a small percentage did so frequently. Across all three seasons, between 17% and 18% of participants never opted out of a single event, and

[24] Opt-outs are defined as participants with greater than zero consumption during at least one hour of their PGE event window. We received hourly data for the EVSE channel and 15-minute data for evPulse. Given the level of data aggregation, we cannot identify customers who charged for just a few minutes. In future analyses, we could explore setting a minimum amount of charging during the hour to be classified as an opt-out. For evPulse, away charging is excluded since charging is not stopped when the vehicle is not at home. Additional information on the opt-out methodology is included in Appendix A.

between 44% and 55% of participants opted out of less than 10% of all events (Figure 26). A small share of participants—between 14% and 17% depending on the event season—opted out of 21% or more of event days.

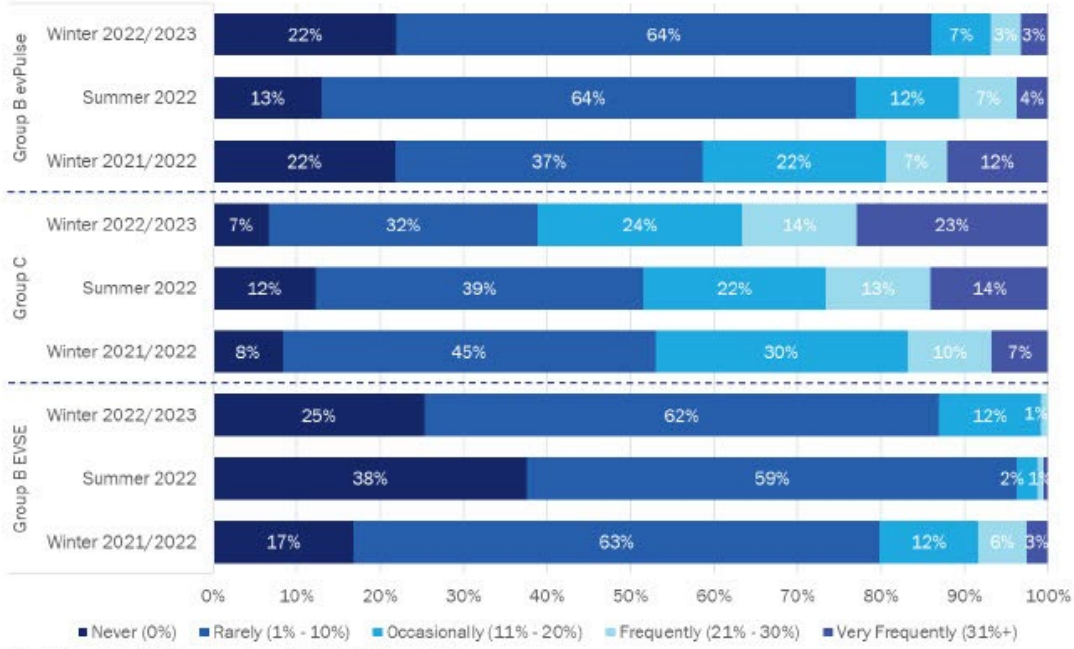
Figure 26. Participant Event Opt-out Rate by Season



Note: Excludes evPulse away charging and PTR event days.

Figure 27 further breaks down the percent of participants who opted out of events by participant group and season. Group C participants were more likely to opt out, while Group B EVSE participants were least likely. No more than 9% of Group B EVSE participants opted out of more than 20% of events. In contrast, at least 17% and as many as 37% of Group C participants opted out of 20% of events. A much higher share Group B EVSE participants never opted out compared to Group C Participants.

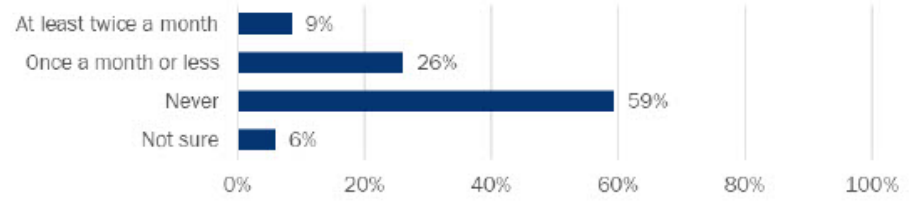
Figure 27. Participant Event Opt-out Rate by Group and Season



Note: Excludes evPulse away charging and PTR event days.

A majority of surveyed Residential Charging Pilot participants reported never opting out of events, which is at odds with the results of charging data opt-out analysis. When asked how often they opted-out or actively charged during events, nearly three-fifths of participants (59%) reported never opting out during the Winter 2022/2023 Event Season (Figure 28). The charging analysis found that just under one-fifth of participants (18%) never charged during their event window. This discrepancy could be due to recall error as the charging analysis found that 44% charged rarely (i.e., 1% to 10% of events). It can be difficult to recall an action that is taken rarely or that may have been done by another household member. It is also possible that some of the charging we identified through the charging data analysis was due to a technological failure, such as when a charger gets disconnected from program control. Pilot implementation partners reported that disconnected chargers were a common issue. Unfortunately, the charging data does not allow us to distinguish between event window charging that is due to deliberate customer behavior versus technological failures. Further exploring reasons for more persistent opt-out behaviors can help identify the underlying causes to help minimize future opt-outs and maximize program performance.

Figure 28. Survey Respondent Reported Event Opt-Out Frequency Winter 2022/2023 Season (n=723)



Note: This question excluded those in Group A (control) who did not experience DR events.

3.8 PEAK PERIODS

Figure 29 illustrates the percent of charging consumption by hour type for each Pilot group. Charging is broken down by on-peak (5:00 p.m.–9:00 p.m.), and off-peak/mid-peak (9:00 p.m.–5:00 p.m.).[25] PGE's designation of peak hours does not align exactly with the pilot's event windows. PGE's peak period includes 8:00 p.m.–9:00 p.m., but the pilot does not control the charging of any group during this hour.

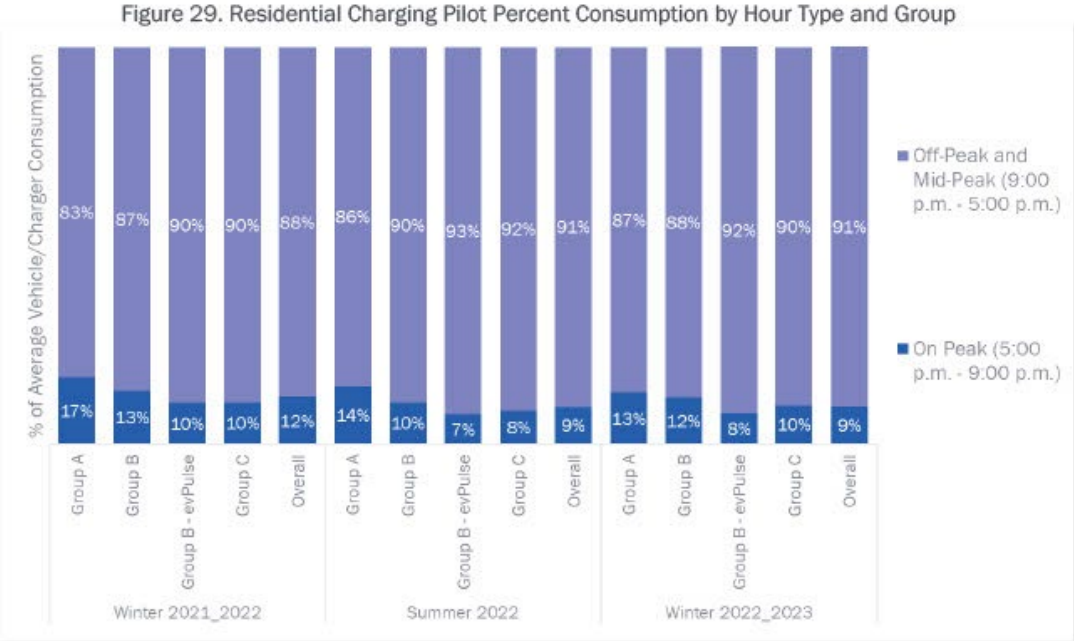
Group A, the control group, conducted a greater share of its EV charging during PGE's system peak period than any of the treatment groups. Group B (EVSE) had the second highest charging percentage during on-peak hours, which is likely due to the end of the Group B event window at 8:00 p.m., which is during peak hours.

Group B evPulse had the lowest percentage of on-peak consumption. Slightly under half of evPulse participants are enrolled in TOD, which encourages them to charge outside of the full peak hours of 5:00 p.m.–9:00 p.m. Group B evPulse.

Group C, which also has a higher percentage of TOD participants, has the second lowest usage during on-peak hours. This pattern suggests that participants are shifting their charging overnight rather than earlier in the day to accommodate both TOD and their event window from 10:00 p.m. to 11:59 p.m.

[25] Peak periods are defined based on PGE's residential TOD plan: https://portlandgeneral.com/about/info/pricing-plans/time-of-day.

Figure 29. Residential Charging Pilot Percent Consumption by Hour Type and Group



Note: Excludes evPulse away charging and PTR event days. Overall is inclusive of Group A.

3.9 NON-COINCIDENT PEAK

EV charging peak load is not frequently coincident with PGE system peak load. Figure 30 summarizes the non-coincident peak load and coincident peak load using monthly system peak hours. Throughout the study period, the non-coincident peak (NCP) load of Residential Charging Pilot participants increased from 336 kW to 3,260 kW. The increase in NCP load is due to more chargers and vehicles enrolling in the pilot. In addition to the non-coincident peak, the evaluation team also investigated the system coincident peak (CP), which represents the charging load peak contribution during PGE's system peak hours. The coincident peak load ranges from 40 kW (364 vehicles/chargers) to 699 kW (1,338 vehicles/chargers), peaking in October 2022.

Figure 30. Residential Charging Pilot NCP and CP

Note: Excludes evPulse away charging and PTR event days.

4. BUSINESS CHARGING REBATES PILOT FINDINGS

This section provides findings from in-depth interviews conducted with Business Charging Rebates Pilot participants and a charging pattern analysis conducted by the team.

4.1 PILOT PARTICIPATION CHARACTERISTICS

Participation in the Business Charging Rebates Pilot has been relatively steady but showed signs of increasing in 2023. In total, 163 Level 2 and four DCFC ports were installed by 29 participating organizations across 42 sites in PGE's services territory during the evaluation period (Table 22). Pilot staff mentioned that changes made to the pilot in November 2022, including expanding increased Level 2 charging rebates for all multifamily customers, installation rebates, and DCFC rebates, has resulted in increased customer engagement, which may be reflected in the increase in overall pilot participation in 2023.[26]

Table 22. Summary of Participation in the Business Charging Rebates Pilot by Installation Year

	2020	2021	2022	2023	Total
Number of Level 2 (Ports)	2	53	52	56	163
DCFC (Ports)	0	0	0	4	4
Participating Organizations	1	8	8	12	29
Participant Sites	1	14	8	19	42

Pilot participant sites are generally associated with public or multifamily sites, with many being multiuse sites. Most sites were for fleet, public, or workplace charging (12 of 42) or public charging only (12 of 24), with about two-fifths (18 of 42) being multiuse sites (Table 23). Few sites were dedicated exclusively to fleet or workplace charging.

Table 23. Business Charging Rebates Pilot Participant Site Use

Site Use	Site Count
Fleet, Public, and Workplace	12
Public Only	12
Multifamily Only	7
Workplace and Public	5
Workplace Only	4
Fleet Only	1
Fleet, Multifamily, Public, and Workplace	1
Total	42

Many Pilot participant sites are located in underserved communities. The evaluation team mapped participant sites to census tracts identified by PGE as containing high proportions of underserved customers – as defined by HB2165 - and found that about three-quarters (32 of 42) of participant sites were located in one or more of the underserved community types, including 108 chargers and 134 charging ports (Table 24). Of the underserved community types,

[26] In November 2022, the pilot increased rebates to $2,300 for multifamily properties, regardless of income eligibility. At that time, the pilot also added new rebates for Level 2 make-ready infrastructure (80 percent of cost up to $6,000 per port), added rebates for DCFCs, and added the ability to reserve rebates for up to 12 months to increase certainty to customers through potentially long development processes. Rebates for make-ready infrastructure and DCFCs were fully reserved in April 2023 and have since been removed from the pilot.

participating sites were most frequently located in communities with high proportions of renters (24 of 42) and communities adversely harmed by environmental health hazards (18 of 42).

Table 24: Business Charging Rebates Pilot Participant Sites, Chargers, and Ports in Underserved Communities (PGE GIS Analysis)

Underserved Community Criteria	Sites	Chargers	Ports
Area with high proportion of renters	24	85	107
Environmental health hazard area	18	72	86
Area with high proportion of multifamily	13	56	75
Communities of color	14	45	55
Low-Income area	10	19	27
Rural area	0	0	0
Tribal area	0	0	0
Any Underserved Community	32	108	134

Note: Underserved community criteria are not mutually exclusive.

The 10 interviewed Pilot participants were generally representative of the participant population (Table 25). Apart from one school property, the group is composed entirely of commercial and multifamily properties. Interviewed participants represent a range of charging end uses. All participants reported that the chargers installed through the program had been in operation for at least six months, with three indicating that they had chargers installed prior to participating that did not qualify for rebates.

Table 25. Summary of Business Charging Rebates Pilot Interviewee Characteristics

Type of Organization	Site Type			Ports Before Participation	Ports After Participation	Approximate Charger Operational Time
	Public	Private	Fleet			
Office Building	Yes	Yes	No	4 Level 2	8 Level 2	12 months
Auto Dealership	No	Yes	No	1 Level 2	2 Level 2; 4 DCFC	8 months
Secondary School	No	No	Yes	0	1 Level 2	9 months
Fitness Center[a]	Yes	Yes	Yes	0	1 Level 2	8 months
Office Building	Yes	Yes	Yes	0	4 Level 2	24 months
Multifamily Building	No	Yes	No	0	2 Level 2	6 months
Multifamily Building[b]	No	Yes	No	0	2 Level 2	30 months
Multifamily Building	No	Yes	No	Unknown	21 Level 2	13 months
Multifamily Building	No	Yes	No	0	4 Level 2	7 months
Multifamily Building	No	Yes	No	0	8 Level 2	8 months

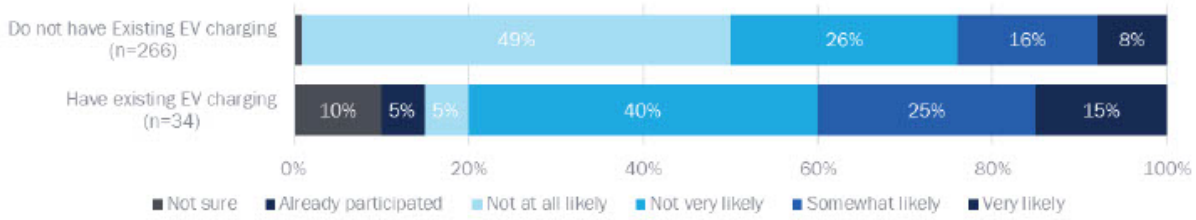
[a] This interviewee installed the EVSE and applied for the rebate on behalf of the participating property.
[b] This participant was a resident of a multifamily property that installed charging at their private parking lot.

4.2 PILOT AWARENESS AND ENROLLMENT

Commercial customers in PGE's service area expressed moderate levels of awareness and interest in participating in the Business Charging Rebates Pilot. Results from PGE's 2023 General Business Survey show that 7% of commercial

customers currently have EV charging on-site.[27] Survey results showed that 35% of customers with EV charging and 14% of customers without EV charging are aware of PGE's Business Charging Rebates Pilot. The few customers who have EV charging onsite and are aware of the pilot are nearly twice as likely to consider participating in the pilot than those who do not have onsite charging (40% vs. 24%, respectively; Figure 31).

Figure 31. Likelihood of Participating in PGE's Business Charging Rebates Pilot Among Those Who Are Aware of the Pilot



Business Charging Rebates Pilot marketing and outreach appear to be sufficient, given the pilot's budget. The Business Charging Rebates Pilot relies on customers visiting the PGE website to learn about rebates or being informed about the pilot by PGE's KCMs, business outreach personnel, or Tech Sales staff. At the time of interviews with pilot staff, the pilot was on track to exhaust funding for 2023 without the need for any additional outreach. Aligning with how the pilot is marketed, interviewed participants recalled learning about the pilot from a PGE account representative (four mentioned), PGE's website, EVSE vendors, and neighboring properties (two mentions each).

More coordination between other PGE non-residential offerings could help increase cross-pilot participation. Pilot staff noted they have not seen non-residential customers come over from other PGE offerings such as Fleet Partner or Energy Partner Pilots. Additionally, customer outreach staff wanted to be more informed about PGE's TE offerings (i.e., Fleet Partner Pilot and Drive Change Fund) to ensure customers they work with are aware of these offerings. In interviews with Fleet Partner Pilot staff (discussed below), the need for more information about other PGE offerings was noted and it was suggested that the KCMs and business outreach staff would be the best sources of such information as they are closest to PGE's commercial customers.

The addition of the pilot rebate reservation has been successful. In November 2022, Pilot staff introduced a reservation system as part of the pilot redesign, which allowed participants to reserve rebates for up to 12 months for those who were going through long development processes. This reservation system has helped staff with planning as it provides insight into which customers were progressing through the pipeline and allows staff to better advise customers on how to submit required documentation to receive rebates. While the reservation system allows staff to see withdrawals from the pilot, none have been reported.

Most participants decide to install charging to provide a new amenity for end users. Seven participants, four multifamily and three commercial office buildings, mentioned that they installed charging on their properties to provide a convenient and safe means of charging for themselves and their tenants (five mentions) or patrons (three mentions). Participants were also motivated to install charging to take first-mover advantage by becoming one of the first companies to adopt EV technology in their industry (two mentions), meet their organization's sustainability goals (two mentions), or expand their fleet charging capacities (one mention).

Incentive levels are sufficient, but most participants indicate they would have installed charging without PGE's assistance. Most participants (7 of 10) mentioned that they would have purchased and installed the chargers without the rebates they received. Of those seven participants, four offered additional motivations for completing the pilot. One

[27] Based on results analyzed from three questions from a PGE-fielded survey with a general population of commercial customers in Q2 2023.

stated that they would have had to move forward with their projects due to new legislation that placed new emission standards on diesel vehicles, two participants mentioned residents' need for on-site charging, and one participant noted auto manufacturer requirements for auto dealerships. Only one participant, a small business, reported that they would not have been able to install charging without the pilot rebates.[28]

4.3 PILOT PARTICIPATION PROCESS

More resources and support for improving the collection and tracking of charger information are needed. In addition to the reservation system, pilot staff also introduced a new online application that allowed participants to submit charger information, other required participant information, and supporting documents (including invoices, W-9s, and charger nameplate photos) more easily. Pilot staff, however, reported challenges completing the build-out of a tool to improve tracking of serial numbers. Data are currently being collected using an Excel-based spreadsheet that lacks features of a data tracking system needed to manage participant information efficiently and accurately. Additionally, staff noted some challenges coordinating with charger vendors to verify serial numbers.

Participants have concerns about agreeing to some of the pilot's participation requirements. Participants mentioned concerns about what they would be liable for if they failed to maintain and operate the chargers before the end of the 10-year period (2 mentions) and about sharing charging data with PGE due to privacy concerns (one mention). Additionally, four participants mentioned challenges with PGE's qualified chargers, including having too many choices and not having the expertise to select chargers best suited for their property, or a lack of vendors carrying sufficient quantities of qualified chargers.

Participants encountered minor issues during the charger procurement and installation process. Four participants experienced delays due to long lead times for equipment deliveries (two mentions), while other participants had issues with a transformer upgrade and a prolonged period of freezing weather (one mention each). The six remaining interviewed participants indicated the installation process was easy and straightforward. However, one of these participants, a multifamily property, struggled to figure out the installation process on their own and suggested that PGE could provide more technical support.

Network connection issues and software issues are the most common issues with the chargers. Participants recalled that their charger issues were most often related to the software interfaces of their charging equipment or the network connection between their charging equipment and cell towers (3 mentions each). Participants stated that these issues were easily resolved. The remaining participants reported that they faced no issues with chargers.

4.4 END USER CHARGING PREFERENCES AND BEHAVIORS

End user charging typically occurs during standard business hours or evenings and charger utilization levels are generally meeting expectations. Apart from multifamily properties with peak usage during the evenings (five mentions), charging at most properties occurs throughout the day (five mentions). Most participants mentioned that end user charger utilization levels are meeting their expectations (eight mentions). One participant mentioned that charger utilization levels are exceeding expectations, with one participant being unsure about the current usage.

Most participants are not exacting payment from their end users for the use of charging stations. All five multifamily participants reported that homeowners and tenants who use the chargers are charged as part of their monthly utility bills. One participant, an office building, mentioned that the first two hours of charging are free, after which users pay a

[28] The interviewed participants are likely to be early adopters of EV charging. We will continue to explore rebate levels in our 2024 participant research.

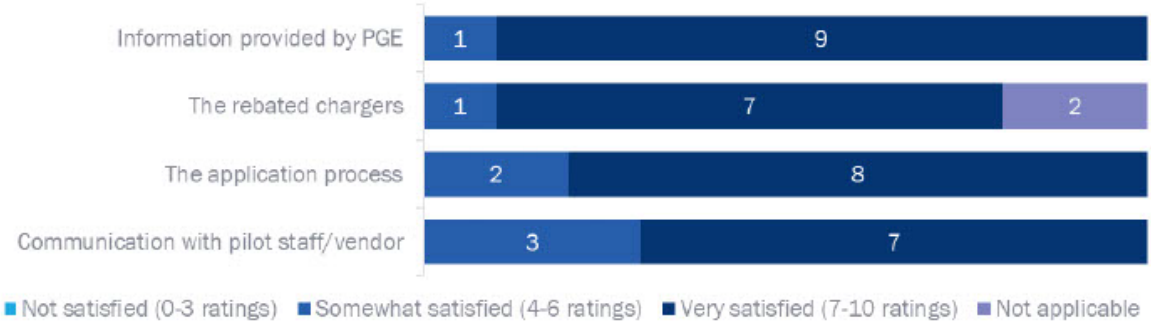
usage fee based on a fixed dollar-per-hour rate and an additional idle fee through their charger vendor's mobile app. The remaining participants mentioned that they are providing charging as a free service to all users.

Most Pilot participants are interested in managed charging but have concerns. Most (7 of 10) participants expressed interest in allowing PGE to manage on-site charging if they could get more information about benefits and requirements. Participants expressed concerns about charging interruptions or restrictions impacting end users. Participants suggested that including an option to manually override charging restrictions (two mentions), and more educational outreach and incentives (one mention each) may address these concerns.

4.5 PILOT PARTICIPANT SATISFACTION

Pilot participants are satisfied with the Business Charging Rebates Pilot. Nearly all (9 of 10) interviewed Pilot participants indicated that they were very satisfied with the information provided by PGE and the chargers they installed (Figure 32). While most participants were very satisfied with their communications with pilot staff or vendors, a few were only somewhat satisfied because of delays in getting pre-approval or assistance with their application from pilot staff, or inconsistent communication from their vendor while repairing their chargers. Two participants did not have direct experience with their chargers and were unable to provide a rating.

Figure 32. Participant Satisfaction with Business Charging Rebates Pilot (n=10)



4.6 BUSINESS CHARGING PATTERN ANALYSIS

For the business charging pattern analysis, the comprehensive database of charging data collected from Pilot participants was transformed by PGE into time series data that was then used to develop average aggregated load curves for participants in the Business Charging Rebates Pilot. We developed average hourly electricity consumption load curves and explored charging patterns overall and by site use. About three-quarters (22 of 29) participants had available data during the reporting period, accounting for four-fifths (33 of 42) of charging sites. Of the participants with available data, two-fifths (13 of 33) were missing data for at least one of their enrolled chargers. More information on the available data is included in Appendix B. It should be noted that across all Pilot participants there was only one DCFC session recorded which was excluded from the analysis.

Across the 112 charging ports at the 33 sites with available data, 24,898 charging sessions were completed from January 2021 through the end of August 2023 in the Business Charging Rebates Pilot. Across all sites and site uses, the average charging duration was just under three hours, and the average plug duration per session was nearly five hours (Table 26). The average electricity dispensed per session was 13.22 kWh. The only site used for fleet charging

had the highest average charge and plug duration (over 12 hours) as well as the highest average electricity dispensed (45 kWh). Variation in sessions across site types was observed (shown in Appendix B).

Table 26. Business Charging Rebates Pilot Session Summaries by Site Use

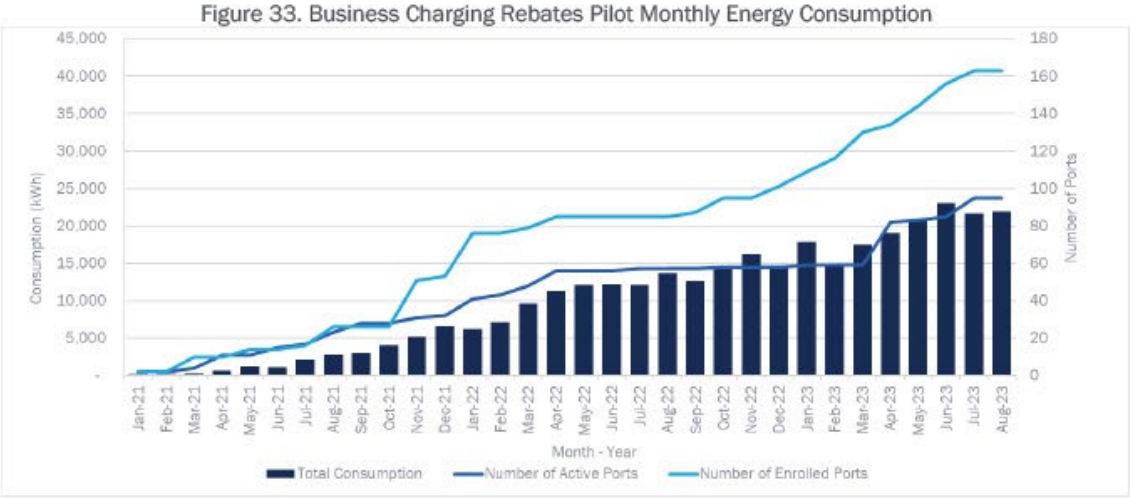
Site Use	Number of Sites	Number of Charger Ports	Number of Sessions	First Charge	Last Charge	Average Charge Duration (hrs.)	Average Plug Duration (hrs.)	Average Electricity Dispensed (kWh)
Fleet, workplace, and public	10	37	14,897	3/29/2021	9/1/2023	2.54	4.00	11.23
Public	12	29	1,643	11/23/2021	9/1/2023	3.62	4.60	19.73
Multifamily	5	10	303	12/31/2020	9/1/2023	3.61	10.27	27.28
Fleet, multifamily, workplace, and public	1	18	6,786	9/5/2021	8/31/2023	2.78	5.77	13.58
Workplace	2	10	889	3/29/2022	9/1/2023	3.67	5.82	18.25
Workplace and public	2	4	137	4/3/2023	8/31/2023	3.49	6.56	13.94
Fleet	1	4	243	5/31/2023	9/1/2023	12.09	15.19	45.07
All	**33**	**112**	**24,898**	**12/31/2020**	**9/1/2023**	**2.83**	**4.79**	**13.22**

4.6.1 CONSUMPTION AND CHARGING PATTERNS

Aggregated monthly energy consumption among Pilot participants increased from January 2021 to August 2023, peaking at 23 MWh in June 2023, as the number of charging ports increased. Figure 33 shows the total consumption per month across all sites with data as well as the number of active charging ports with data.[29] As anticipated, the general trend shows that monthly energy consumption increased as ports were added. From May 2022 to March 2023, the number of active ports stayed relatively constant, but consumption continued to increase, suggesting there was an intensification of use per port during that time.

[29] There were 33 sites with available session data; however, one of these sites had insufficient interval data (<24 hours of data).

Figure 33. Business Charging Rebates Pilot Monthly Energy Consumption



Note: A port is considered active between its first and last recorded charging session. A port is considered enrolled based on its install and retirement date.

The average charging load for all the Business Charging Rebates Pilot sites combined is plotted in Figure 34. The average load profile starts to ramp up around 6:00 a.m. and then gradually decreases after 10:00 a.m. We grouped and analyzed Business Charging Rebates Pilot participants by site type and investigated the usage pattern differences between these groups.

The average daily consumption varies considerably by site use; however, due to the relatively small number of sites, this may be due to the charging of specific Pilot participants rather than site use (Figure 35). Sites used for fleets, workplace, and mixed usage generally have peaks during working hours, while public and multifamily sites appear to be more evenly distributed throughout the day. The load shape representing only fleet charging is from a single site and has the highest mean hourly consumption reaching over 2.5 kW around 10:00 a.m.

Figure 34. Business Charging Rebates Pilot Average Load Curve (n=32)

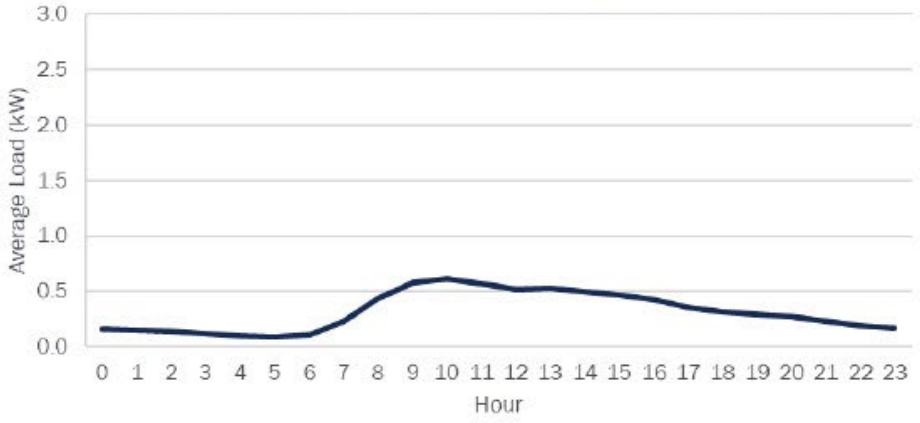
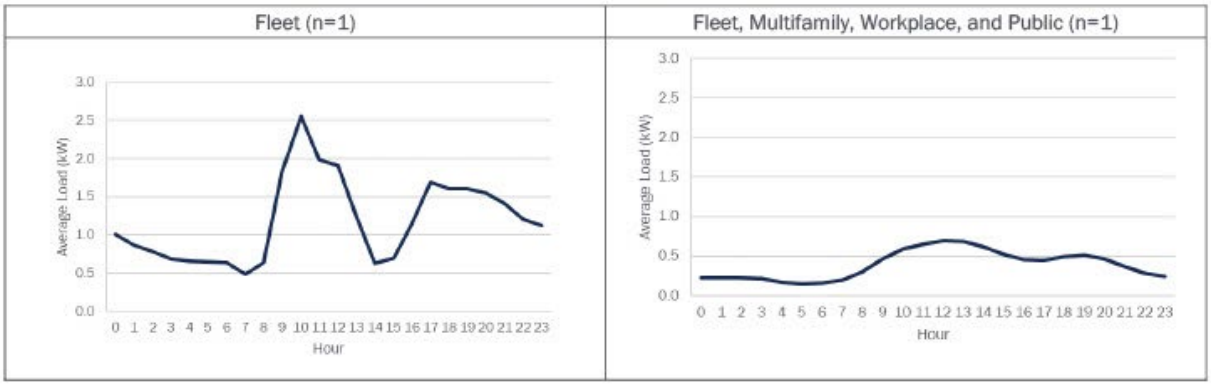
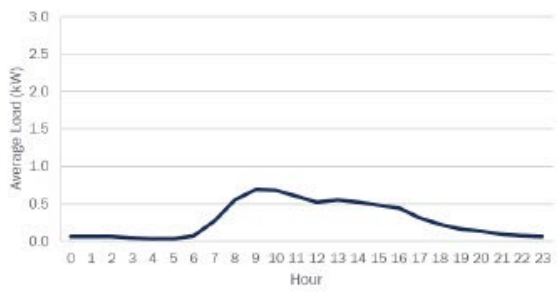


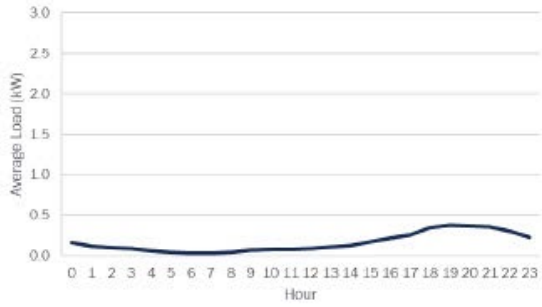
Figure 35. Business Charging Rebates Pilot Average Load Curve by Site Use



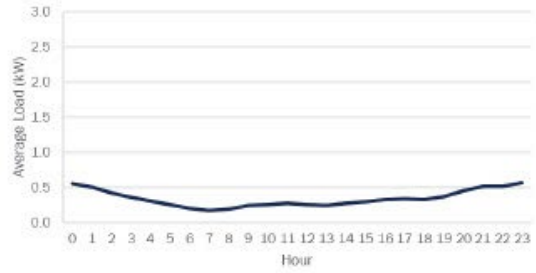
Fleet, Workplace, and Public (n=10)



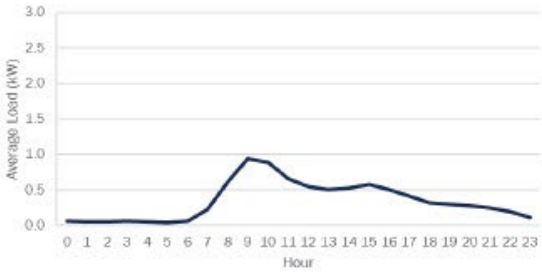
Multifamily (n=4)



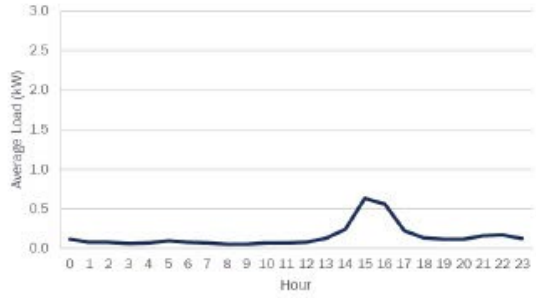
Public (n=12)



Workplace (n=2)



Workplace and Public (n=2)



4.6.2 PEAK IMPACT

Of the Business Charging Rebates Pilot sites with data, 11 were enrolled on a standard rate, PGE's Schedule 32. The remaining 21 sites were enrolled on a TOU rate, either PGE's Schedule 83 (16), Schedule 85 (4), or Schedule 38 (1).

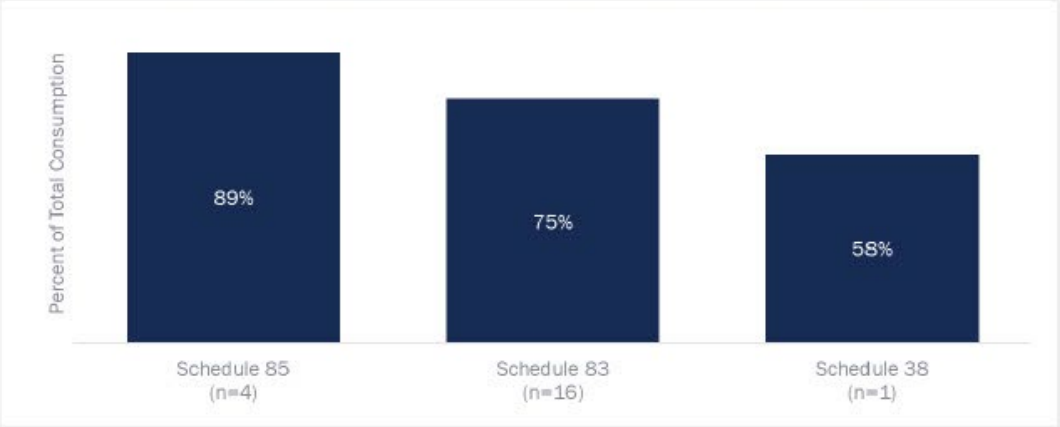
Table 27. Business Charging Rebates Pilot Sites Use and Rates

Rate	Site Use	Number of Sites
Schedule 32	Fleet; Workplace; Public	2
	Multifamily	3
	Public	3
	Workplace	1
	Workplace; Public	2
Schedule 38	Fleet	1
Schedule 83	Fleet; Multifamily; Workplace; Public	1
	Fleet; Workplace; Public	6
	Multifamily	1
	Public	8
Schedule 85	Fleet; Workplace; Public	2
	Public	1
	Workplace	1

Note: Rate designation is defined by current rate. It is possible that sites were on a different rate at other points in time during the reporting period. The table only shows sites that had available session data.

Across all TOU schedules, more than half of total consumption occurred during on-peak hours. Sites on Schedule 85 had the highest percentage of their total consumption occur during peak hours (89%) compared to sites on Schedule 83 (75%) and Schedule 38 (58%) (Figure 36). Due to the relatively small number of sites, this may be due to charging at specific sites rather than trends of participants enrolled in each rate.

Figure 36. Business Charging Rebates Pilot On-Peak Energy Consumption by Rate

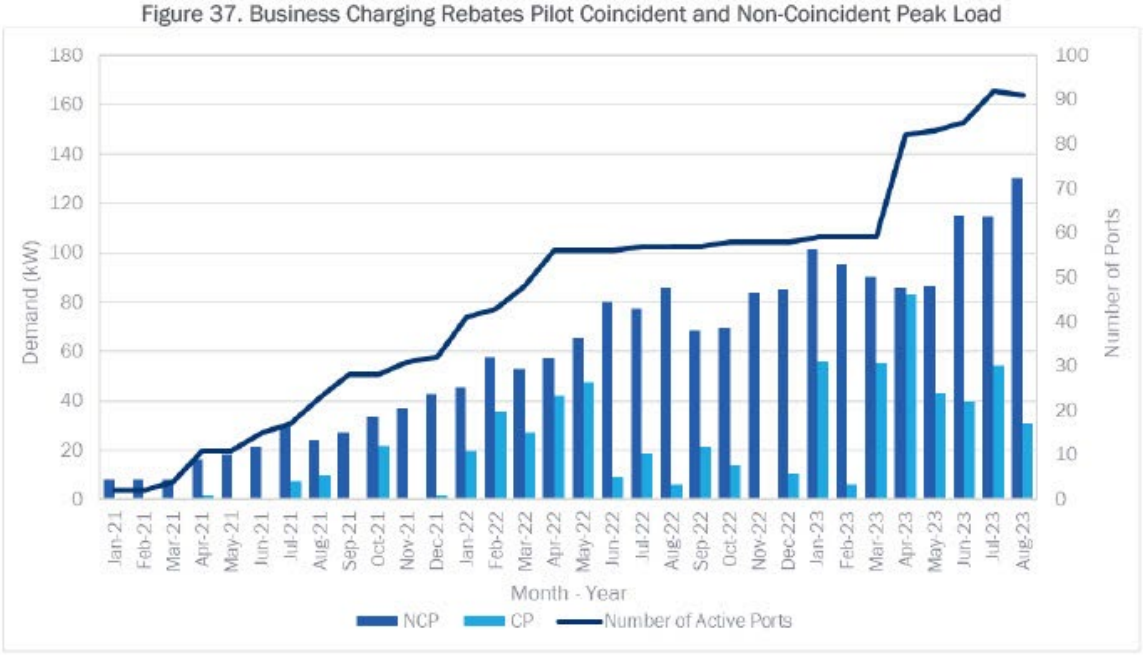


Note: Rate designation is defined by current rate. It is possible that sites were on a different rate at other points in time during the reporting period. In this figure, "n" is the number of sites.

Throughout the study period, the non-coincident peak (NCP) load of Business Charging Rebates Pilot sites increased. The NCP increases from 8 kW (2 active charging ports) to a peak of 130 kW (91 active charging ports) as additional sites and ports are activated (Figure 37). In addition to the NCP, the evaluation team also investigated the system

coincident (CP), which represents the charging load peak during PGE's system peak hours. Our analysis shows that peak charging load does not frequently coincide with PGE system peak load.

Figure 37. Business Charging Rebates Pilot Coincident and Non-Coincident Peak Load



The load factor of all charging generally increased until November 2022 but then steadily decreased through August.[30] During the study period, load factors ranged from 1% on June 2021 to 7% in November 2022, with an average load factor of 4% (Figure 38). Low load factors indicate that the average consumption is a very small percentage of the maximum consumption per site meaning that there are periods of very high usage but a relatively low rate of utilization. The decrease in load factors over time is likely due to new ports and sites coming online that had lower utilization rates relative to their maximum consumption.

[30] The load factor is the ratio of average charging load to the maximum charging load over a given period of time. Here the load factor is calculated as the average charging load divided by the maximum load averaged across sites for each month of the study period.

Figure 38. Business Charging Rebates Pilot Load Factor per Month

4.6.3 CHARGER UTILIZATION

Port utilization rates varied greatly between site types, with most site types showing low utilization. Port utilization is reported in two ways. The first is charge utilization, which identifies the percentage of time that the port is actively in use, relative to the time it is available. The second is plug utilization, which identifies the percentage of time that a vehicle is plugged into a port, regardless of whether or not it is actively charging, relative to the time it is available. The average port in the pilot had a charge utilization of 7% and a plug utilization of 11%. Higher plug utilization is expected given that EVs are often plugged in for longer than they are charging, but large differences in these two rates indicate that there are times when the charger is idle (not charging) but unavailable (vehicle plugged in). Port charge utilization rates varied from 3% at workplace and public sites to 33% at sites used for fleet charging (Table 28). As anticipated, port plug utilization rates were higher than port charge utilization rates, ranging from 5% to 42%. Additional information on utilization rates at the site level is included in Appendix A.

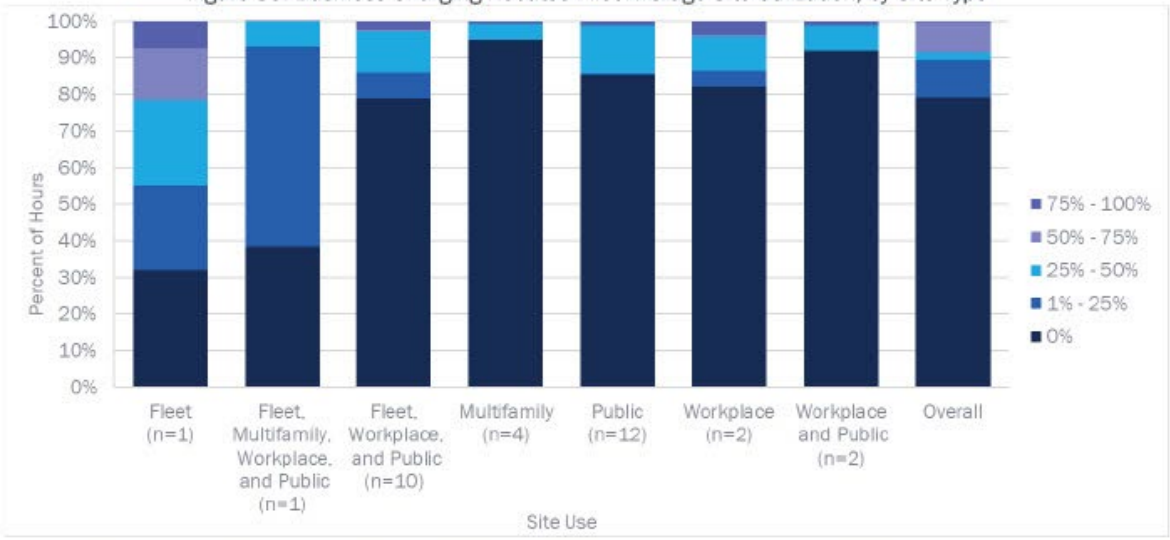
Table 28. Business Charging Rebates Pilot Charging Ports and Plug Utilization Rates

Site Type	Number of Charging Ports	Average Port Charge Utilization	Average Port Plug Utilization
Fleet, Workplace, Public	37	7%	11%
Public	26	4%	5%
Multifamily	8	4%	5%
Fleet, Multifamily, Workplace, Public	18	7%	16%
Workplace	9	6%	9%
Workplace, Public	4	3%	7%
Fleet	4	33%	42%
All	**106**	**7%**	**11%**

Note: Utilization rates are calculated assuming that all chargers are active from their first session through their last session. Utilization rates cannot be calculated for chargers with only one session; these chargers are excluded from this table.

The average site had all chargers available approximately 80% of the time, including overnight hours and weekends. Utilization varied significantly between sites, with some sites never having more than 50% of available ports in use. It was rare that all the chargers at a site were in use at the same time (<0.5% of the average day), suggesting that charging ports are usually available at pilot sites (Figure 39).

Figure 39. Business Charging Rebates Pilot Average Site Utilization, by Site Type



Note: Average daily utilization is calculated by identifying the number of ports charging versus the number of ports available per site per date per hour (across all days and all hours) since a site's first session.

5. FLEET PARTNER PILOT FINDINGS

This section provides findings from interviews and surveys conducted with Fleet Partner Pilot participants and the evaluation team's charging pattern analysis.

5.1 PILOT PARTICIPATION CHARACTERISTICS

Participation in the Fleet Partner Pilot program has been steady since it was launched in July 2021, but most projects have not yet moved on to the Build phase. As of August 2023, 39 participants had completed the Plan phase of the pilot but just seven participants (representing eight charging sites and 42 charging ports) completed the Build phase (Table 29). Ten customers withdrew their applications. Funding for make-ready build-out was fully reserved in early 2023. Staff noted challenges in communicating funding issues to customers, citing the risk of discouraging committed and eligible customers from pursuing participation. Moreover, by the time funding does become available, incentive levels will be reduced, which may cause customers to reconsider moving forward with the Build phase. By 2024, PGE forecasts that up to 75 sites may participate in the pilot.

To date, the pilot has had more participants in the public sector than the private sector. The evaluation team mapped participant sites to census tracts identified by PGE as containing high proportions of underserved customers as defined by HB2165 and found that half (4 of 8) of operational charging sites are located in underserved communities, including 15 chargers and 21 charging ports. Of the underserved community types, three sites were located in low-income areas, two were located in communities adversely harmed by environmental health hazards, and two were located in areas with high proportions of renters.

Table 29. Summary of Participation in the Fleet Partner Pilot Since July 2021

Sector	Withdrawn Sites	Completed Plan Phase Sites	Completed Build Phase	
			Sites	Ports
Public[a]	5	25	6	34
Private[b]	5	14	2	8
Total	10	39	8	42

[a] A public organization refers to any government and government-controlled enterprise responsible for the administration of a public service such as a public school district, mass transit agency, wildlife conservancy, water district, or public park and recreation center.

[b] A private organization refers to any for-profit and non-profit enterprise or one of its subsidiaries not owned or controlled by the government such as a sole proprietorship, partnership, small or mid-sized business, large corporation, multinational, trade union, or professional/trade association.

Interviewed and surveyed participants were generally representative of the participant population (Table 30). Among Build phase participants, all reported that the chargers they procured are currently installed and operational. All Build phase interviewees stated that their fleet vehicles are parked on-site, but two mentioned that some of their light-duty fleet vehicles may be taken home by employees with specialized roles within their organization. Among Plan phase participants, all reported that they had received a Fleet Partner Study through the pilot but had not started the installation process. Additionally, all Plan phase interviewees stated that their fleet vehicles are parked on-site, but two mentioned that some of their fleet vehicles may be taken home by employees.

Table 30. Characteristics of Fleet Partner Pilot Participant Interviewees and Survey Respondents (n=17)[a]

Program Phase	Sector	Type of Organization	Current EVs	Approximate Fleet Size	Ports Installed Before Participation
Build	Public	Government Entity	0	90	0
Build	Public	Government Entity	4 EVs, 10 PHEVs	180	4 L2
Build	Public	Government Entity	1 EV	161	2 L2
Build[b]	Public	School District	2 EVs	192	0
Plan	Private	Moving & Storage	0	Unknown	0
Plan	Public	Government Entity	0	Unknown	0
Plan	Public	Government Entity	0	Unknown	0
Plan	Public	Public Transit	10 EVs	Unknown	12 DCFC
Plan	Public	Public Transit	1 EV	Unknown	2 L2
Plan	Private	Food Production	0	Unknown	0
Plan	Public	Parks & Recreation	0	Unknown	0
Plan	Public	Public Transit	10 EVs	Unknown	29 L2
Plan	Private	Interstate Freight Carrier	0	Unknown	0
Withdrew	Private	Transit Bus Contractor	0	845	0
Withdrew	Private	Electrical Contractor	0	355	0
Withdrew	Public	Parks & Recreation	4 EVs, 3 PHEVs	100	0
Withdrew[c]	Private	Auto Dealership	8 EVs	8	4 L2

[a] We conducted in-depth interviews with those in the Build phase of the pilot as well as those who withdrew. For those in the Plan phase of the pilot, online surveys were conducted.

[b] This participant procured both EVs after enrolling in the pilot.

[c] This interviewee mentioned that they already had eight EVs and wanted to know if the pilot could provide incentives for upgrading their existing charging.

For the process-related findings presented below, we combine responses from the 17 participants who participated in interviews and surveys, noting meaningful differences between the participant types (i.e., withdrawn, Plan phase, and Build phase participants) when they exist.

5.2 PILOT AWARENESS, SOURCES OF INFORMATION, AND MOTIVATIONS

Leveraging PGE staff's knowledge and existing relationships with customers to promote the pilot has been effective. Large commercial customers often have existing relationships with PGE's KCMs, local government affairs, and business outreach staff that inform them about PGE offerings via presentations and email outreach. The product team's Salesforce dashboard, which tracks outbound phone calls and follow-up email communications, and annual business review events have also helped to reach customers who might not already have an existing relationship with PGE staff. In addition to maintaining a webpage devoted to the pilot, PGE also has used LinkedIn postings, ride-and-drive events, and tabling at the 2022 Green Transportation Summit and Expo to reach fleet customers. Nine interviewed fleet managers reported learning about the Fleet Partner Pilot from PGE's KCMs (seven mentions) or local government affairs liaisons (two mentions) via meeting or email. Two fleet managers reached out to PGE to learn how they can install make-ready infrastructure for electric school buses. Others learned about the pilot from other municipalities or fleet vehicle vendors (two mentions each).

KCM and business outreach staff need help to stay current on PGE transportation electrification offerings and want to be more involved during the participation process to support their customers. KCMs and business outreach staff would like more information about PGE's transportation electrification offerings. They would also like to be more involved during the Fleet Partner Pilot participation process, including attending their customers' project kickoff meetings. KCMs

and business outreach staff suggested that pilot staff include them in project meetings and provide regular updates about changes to the pilot, so they can provide customers with accurate information and communicate customer needs.

Fleet managers are typically well connected to a network of resources for supporting fleet managers pursuing fleet electrification. Most Pilot participants report utilizing a wide variety of sources to gain information about fleet vehicles or fleet management, including online fleet management resources (12 mentions), industry publications (11 mentions), colleagues (10 mentions), conferences or expos (seven mentions), and auto dealerships (five mentions). Most of these participants receive emails and newsletters from these sources with information that allows them to stay up to date on current trends and upcoming events where they may receive education and training on operating and maintaining fleet vehicles and fleet management systems.

A primary motivation for pilot participation appears to be existing company/organizational goals for fleet electrification. All interviewed fleet managers said that they were seriously considering electrifying their fleets prior to learning about the pilot. Fleet managers mentioned various reasons for electrifying their fleet, including:

- Lowering their fleet operating costs (six mentions)
- Improving air quality (five mentions)
- Encouraging others to adopt EVs (five mentions)
- Inspiring communities to be good stewards of the environment (four mentions)
- Improving their organization's brand image (three mentions)
- Providing an employee perk (one mention)
- Motivations for participating in the Fleet Partner Pilot included:
- Accessing technical assistance (e.g., charger recommendations, comprehensive site assessment, turnkey design, and construction planning) (13 mentions)
- Financial assistance (13 mentions)
- Cost estimates associated with fleet electrification (11 mentions)

5.3 PILOT REQUIREMENTS

Meeting the pilot's new load requirements, energy-use commitments, and easement requirements were challenging for participants. To participate in the pilot, customers are required to add a minimum of 70 kW of new load (usually equivalent to 10 Level 2 ports or one to two DC fast chargers) at the customer site and sign an easement covering PGE-owned infrastructure. One interviewee mentioned that their company was unlikely to meet the minimum 70 kW requirement because that would require them to use more EVs than they had. Four other fleet managers recalled that the energy-use commitment imposed too many restrictions on participation and withdrew from the Pilot because of concerns about meeting this requirement. One interviewee elaborated, saying that after doing their own calculations using their fleet maintenance provider's vehicle management portal and EV fleet vehicle manufacturer data, they found that they could not meet this requirement.

> "When we first, initially, were talking with them, we're kind of like, 'Oh, yeah, maybe we could do a couple of vehicles, a couple SUVs, and then a couple of trucks...' We went from thinking about 50 miles a day as the base, but we found out it was more like 15. So it was one of the things that we're a little concerned about was meeting those kWh requirements. And in the end, having to pay back."

Additionally, three fleet managers mentioned having concerns about the liabilities to the property owners for signing the easement, of which two reported experiencing significant delays due to prolonged legal negotiations between PGE's legal team and their landlords to address those concerns.

5.4 FLEET ELECTRIFICATION TECHNICAL ASSISTANCE

The technical assistance provided by the pilot is appropriate and highly valued by participants, but some participants may need additional support. Most participants reported that the technical assistance they received from PGE (e.g., charger recommendations, comprehensive site assessment, design, and construction planning) was satisfactory, but three participants went on to specify additional technical assistance that they desired. One Plan phase participant mentioned they would like more details on results from the charging, fuel cost, and energy use analysis. For example, more clear explanation of cost and savings assumptions, detailed documentation of sources used to develop assumptions, and additional documentation of emissions reductions. One Build phase participant would have liked additional assistance in determining the optimal number of chargers needed for their fleet. Another Build phase participant stated that they would have liked upfront information about their site's vehicle-to-grid (V2G) capabilities before they moved forward with purchasing V2G-enabled chargers for their site.

PGE's online Total Cost of Ownership (TCO) tool is useful but lacks visibility and advanced features some customers require. The TCO tool is a free fleet planning tool featured on PGE's website that allows fleet managers to calculate the costs and savings associated with electrifying their fleet. Seven out of 17 fleet managers reported using the TCO tool. Those managers who reported using the tool generally found it useful but suggested a need for features that capture demand charges and projected energy usage may impact their monthly bills. Fleet managers that had never used the TCO tool said it was because they were not aware of it (six mentions) or because they were already using a report generated by a similar tool (one mention).

5.5 PROJECT TIMELINE

The initial staffing arrangement for Design Project Managers (DPMs) led to some project delays but was later rectified. The DPM team oversees utility infrastructure designs for every project in the Fleet Partner Pilot during the Build phase. To simplify the Build phase, there was initially only one DPM available in 2022 to work with contractors on final project designs. While the sole DPM performed high-quality work, they became overextended with the influx of new fleet projects, prompting pilot staff to bring in regional DPMs. The addition of regional DPMs (existing PGE staff) has since reduced project delays.

The time it takes to confirm customers' reservations to proceed to the Build phase is adequate for customers. Four Build phase participants reportedly went through a period of waiting to confirm their reservations, all of whom reported that the typical process duration (2 to 3 weeks) was reasonable. One participant reported waiting approximately six months to confirm their reservation and noted that the causes of the delays were a parking lot expansion and a soil study that was done to prepare the site for construction.

Supply chain issues associated with charging infrastructure equipment have increased project timelines and costs. Procuring charging infrastructure equipment has been difficult for the past couple of years due to global supply chain issues. Staff have seen delays in deliveries of transformers of up to 56 weeks and switchgears of up to 65 weeks. All interviewed Build phase participants reported that their completion dates were set back for up to six months due to supply chain issues. These long delays contributed to discrepancies between the estimated and actual costs for a handful of projects. One interviewed inactive fleet manager mentioned that this is essentially a manufacturing problem that the pilot cannot alleviate. Still, PGE staff mentioned that ordering equipment months ahead of the expected delivery date has helped with equipment deliveries and capital planning.

Changes in staffing at customer organizations during the participation process have been an ongoing challenge for fleet electrification and participation. Staff turnover at potential participant organizations can lead to missed funding opportunities or deadlines to submit applications. Two organizations reported that when the time came for them to sign and submit their applications, project leads had been replaced with new staff who were not familiar with the project. One of the organizations reportedly lost a funding opportunity, vital to the feasibility of their project. Pilot staff also find that it becomes increasingly difficult to get project approval when an organization adds more staff to the internal approval process.

5.6 MAKE-READY INCENTIVE LEVELS AND COST ESTIMATES

Phase 1 incentive levels were sufficient for most participants and were not a reason why interviewed inactive fleet managers withdrew from the pilot. As of Augst 2023, most customers found the incentive levels either met (10 mentions) or exceeded (two mentions) their expectations. One Plan phase fleet manager acknowledged that the incentive amount was sufficient at first but was subsequently insufficient to cover the expected 50% of the total cost of construction, due to their existing infrastructure not meeting the requirements to support EV charging. The remaining customers were unable to recall their estimated incentive amounts. Note that incentive levels have since decreased in Phase 2 of the Pilot. Customers who withdrew from the pilot stated that their withdrawal reasons were unrelated to incentives but rather the challenges of meeting the pilot's minimum 70 kW new load requirements or energy-usage commitments discussed above.

Secondary research conducted by the evaluation team suggests that Phase 1 incentive levels align with other utility program offerings. However, making direct comparisons is challenging due to the variety of program and incentive configurations of fleet electrification utility programs. In addition to gathering feedback from Pilot participants on make-ready incentive levels, the team reviewed program designs and incentive levels for 13 different fleet electrification programs offered by utilities across the United States. Given the varied program designs and incentive levels, it was not possible to identify a typical incentive level. However, key program design elements were identified along with a range of incentives for current fleet electrification offerings.[31]

- Eight out of 13 fleet electrification programs offered incentives for both make-ready infrastructure and EVSE projects, with four offering additional incentives for electric fleet vehicle procurement. Additionally, one program provided grant-finding and writing support for EVSE projects.
- Maximum incentive levels for make-ready infrastructure projects varied based on customer charging needs, the type of community that the proposed project would serve, and the type of fleet vehicles that would use the charging infrastructure. Eligible customers enrolled in these programs may receive incentives covering anywhere between 50% to 100% of the upfront costs for make-ready projects.
- EVSE incentive levels varied by utility, ranging from $500 to $4,500 per serviced Level 1 or Level 2 charger and $7,500 to $30,000 for DC fast chargers.

A lack of financial resources to install chargers caused major setbacks to some organizations' fleet electrification plans. Four participants who completed the Fleet Study reported that they were unable to receive funding from PGE. One participant reported having enough funds to install their desired number of chargers without PGE's assistance, but two had to adjust their plans to start small and apply for federal or state grants. One participant who had not moved forward due to lack of funding stated that they had begun looking into grants outside of Oregon. All interviewed Build phase participants stated that they would have proceeded with their projects without the incentives they received from PGE, but half mentioned that they would have had to scale back their projects without the incentives.

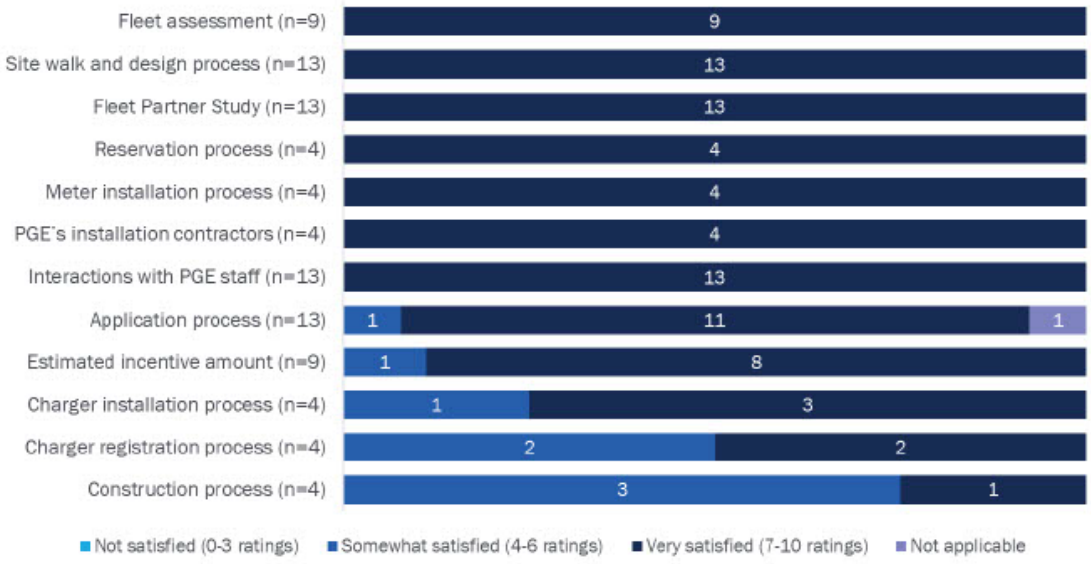
[31] Table 49 in Appendix D provides a summary of the 13 programs reviewed allowing for a comparison of these programs with the Fleet Partner Pilot's participation requirements and incentive levels.

The cost estimates in the preliminary designs were mostly accurate, but there were some inaccuracies due to issues in the predictive model of the TCO tool. Seven Plan and Build phase participants reported that the cost estimates in the preliminary designs met expectations, while the remaining six participants reported that estimated costs for electrifying their fleet were higher than expected. Of the six participants who reported inaccuracies in their cost estimates, five reported that they had used the TCO tool discussed above. While some were unsure of the reasons, one Plan phase participant speculated that the TCO tool did not factor in all the potential factors for accurately determining costs and commitments discussed above. Others attributed the deviations to the impacts of inflation on the cost of equipment (1 mention) and added labor costs incurred due to design changes made by PGE engineers (1 mention).

5.7 PILOT PARTICIPANT SATISFACTION

Participants reported high levels of satisfaction with the Pilot. All interviewed participants indicated they were very satisfied with most elements of the Fleet Partner Pilot (Figure 40). Participants were somewhat less satisfied with the charger registration and make-ready construction process. Two Build phase participants reported that completing the make-ready construction process was straightforward, but one went on to mention that inconsistent notices from their construction companies about construction visits led to a poor make-ready construction experience. The other participants reported experiencing some unexpected delays. One stated that their construction start date was set back due to an additional easement they needed to complete a line extension that would pass through a part of the property that a neighboring organization privately owned. The other participant recalled the permitting process being delayed due to safety examinations of the underground lines that were to be connected to the charging equipment.

Figure 40. Participant Satisfaction with Fleet Partner Pilot[a]



[a] Inactive participants were not asked to rate their satisfaction with the pilot and are not included in the above figure. Items with 13 responses were asked of both Plan and Build phase participants, items with 9 responses were asked of only Plan phase participants, items with 4 responses were only asked of Build phase participants. Note one participant did not have direct experience with the application process and was unable to provide a rating.

5.8 INTEREST IN UTILITY MANAGED CHARGING

Most Pilot participants are interested in utility managed charging but need to learn more before signing up. Nine participants were interested in participating in a managed charging program. Most of these participants stated that while they have no specific concerns, they would like more information to fully understand how such a program would impact their organization. One Build phase participant stated that their only concern would be how the programs would impact their capacity to handle emergency situations such as extreme weather events or medical situations in which people would need to be transported reliably and quickly. Two Build phase participants mentioned that they had already adopted building energy management systems and that they are comfortable with PGE remotely managing when they charge.

5.9 FLEET CHARGING PATTERN ANALYSIS

The charging pattern analysis for the Fleet Partner Pilot is limited to the sites and chargers that had available charging data by the end of August 2023. We received charging data for three out of seven participants comprising 17 of 36 chargers installed through the pilot. Two of the sites for which we received data were missing data for one or more chargers. Below is a summary of available data relative to pilot participants in Table 31. Only public/government customers had available data. Charging data evaluated are only from Level 2 chargers as no DCFCs had charging data available. Additional information on charging data availability is included in Appendix C.

Table 31. Fleet Partner Pilot Participation Overview

Customer	Customer Type	Number of Sites	Number of Chargers	Chargers with Data
200001	Private	1	1	No data – No vehicles to charge
200002	Public	1	3	No data – Chargers not installed until August 2023
200008	Public	1	6	6
200009	Public	1	10	9
200051	Private	1	6	No data – Missing data from the charging vendor
200449	Public	2	6	No data– Chargers not installed until August 2023
201361	Public	1	4	2

Across the 17 chargers, there were 245 charging sessions during the study period. Most sessions occurred at Site 100011 (199), with Site 102190 recording the lowest number of sessions at 13. Overall, average charging and session duration vary greatly between sites (Table 32). The average electricity dispensed per session was 8.49 kWh per session. Additional details on variations between chargers at each site can be found in Appendix C.

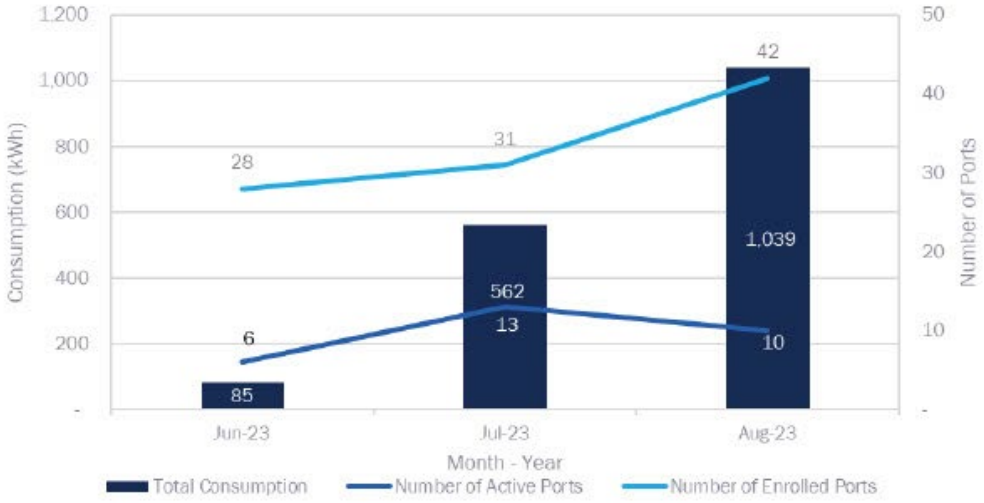
Table 32. Fleet Partner Pilot Charging Sessions Summaries by Site

Site	Site Use	Number of Charger Ports	Number of Sessions	First Charge	Last Charge	Average Charge Duration (hrs.)	Average Session Duration (hrs.)	Average Electricity Dispensed (kWh)
100011	Fleet	6	199	6/29/2023	8/31/2023	1.94	8.63	6.38
100014	Fleet, workplace, and public	9	33	6/2/2023	8/26/2023	2.47	2.98	14.66
102190	Fleet and workplace	2	13	7/10/2023	8/30/2023	4.04	6.32	25.07
Total	**All**	**17**	**245**	**6/2/2023**	**8/31/2023**	**2.13**	**7.74**	**8.49**

5.9.1 CONSUMPTION AND CHARGING PATTERNS

Aggregated monthly energy consumption increased from June 2023 to August 2023, reaching a peak of 1,039 kWh in August. Given the short period Fleet Partner sites have been active and the small number of chargers with data, in-depth analysis of timeline trends and patterns is limited. Figure 41 shows the total consumption per month across all sites with data as well as the number of charging ports with data. There is an increase in the number of chargers with data between June and July 2023 but a decrease between July and August 2023. This is not due to the chargers being retired or removed from the pilot but rather because no sessions were recorded in August for some of the chargers (this could be due to missing data, the charger being offline, or no sessions occurring). The increase in consumption in August 2023 is therefore likely due to the increased use of existing chargers.

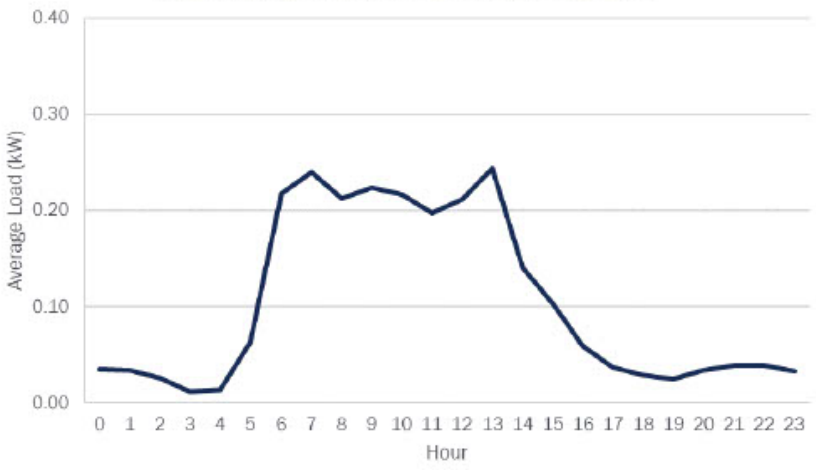
Figure 41. Fleet Partner Pilot Monthly Energy Consumption



Note: A port is considered active between its first and last recorded charging session. A port is considered enrolled based on its install and retirement date.

The average charging load for Fleet Partner sites combined is plotted in Figure 42. The average daily load profile starts to ramp up around 6:00 a.m. and the load decreases after 1:00 p.m. Load curves for the individual sites, and variations between day types, are in Appendix C.

Figure 42. Fleet Partner Pilot Average Load Curve

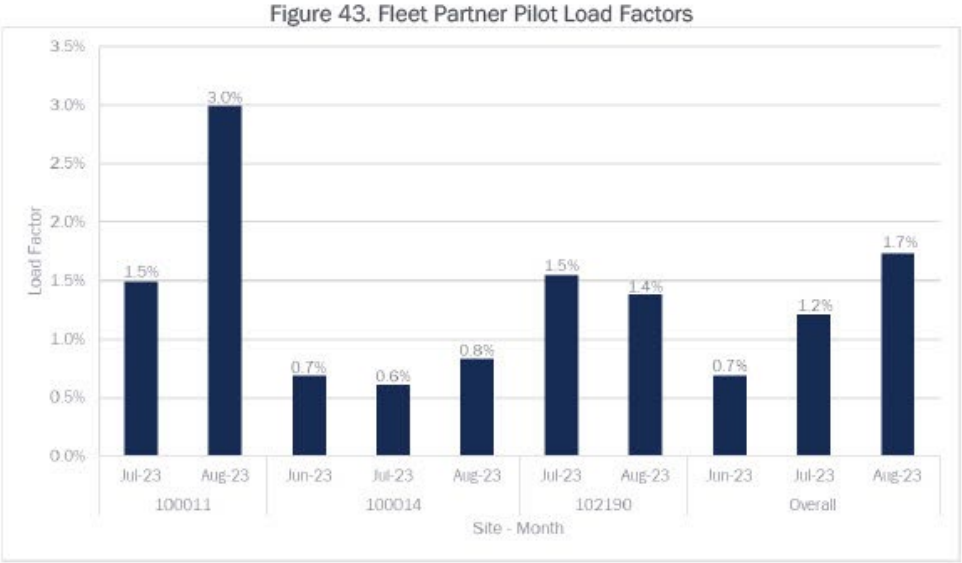


5.9.2 PEAK IMPACT

No Fleet Partner Pilot sites with available data were enrolled on a TOU rate at the time of the 2023 evaluation, therefore, TOU rate exploration was excluded from this analysis. Additional analysis will be conducted in 2024 when additional sites come online.

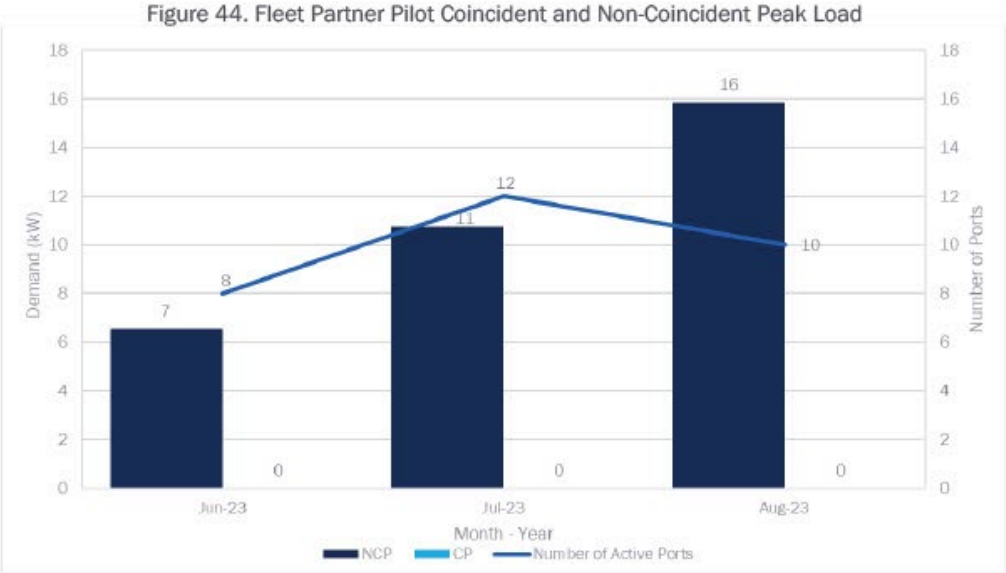
Throughout the study period, the load factor of charging across all sites increased but remained relatively low. Load factors for each site and, overall, for all months are included in Figure 43. Low load factors indicate that the average consumption per site is a very small percentage of the maximum consumption per site, meaning that there are periods of relatively high usage but there is a relatively low rate of utilization. The increase in load factors seen between months, overall, can likely be attributed to the increased usage of existing chargers relative to the maximum demand. This is largely driven by the increase in consumption of Site 100011 relative to the maximum consumption of that site. Given the limitations in the number of activated sites and timeframe, additional data is needed to establish more conclusive trends.

Figure 43. Fleet Partner Pilot Load Factors



Throughout the study period, the NCP load of Fleet Partner sites increased. The NCP increases from 7 kW (8 active charging ports) to a peak of 16 kW (10 active charging ports) as additional sites and ports are activated (Figure 44). In addition to the non-coincident peak, the evaluation team also investigated the system coincident peak (CP), which represents the charging load peak contribution during PGE's system peak hours. Our analysis indicates that charging peak load is not frequently coincident with PGE system peak load.

Figure 44. Fleet Partner Pilot Coincident and Non-Coincident Peak Load



5.9.3 CHARGER UTILIZATION

Port charging and plug utilization rates varied greatly between Fleet Partner sites. Port charge utilization rates varied from 2% to almost 4% across sites (Table 33). Port plug port utilization rates ranged from 2% to 20%. At fleet Site 100011, plug utilization was over three times higher than charge utilization, which is expected as fleet EVs are often plugged in for longer than they are charged.

Table 33. Fleet Partner Pilot Charger and Plug Utilization

Site	Number of Charger Ports	Average Port Charge Utilization	Average Port Plug Utilization
100011	6	4%	20%
100014	6	2%	2%
102190	2	2%	3%
Total	**14**	**2%**	**8%**

Note: Utilization rates are calculated assuming that all chargers are active from their first session through their last session. Utilization rates cannot be calculated for chargers with only one session, and so any such chargers are excluded from the average.

APPENDIX A. RESIDENTIAL CHARGING PILOT: IMPACT ANALYSIS METHODS AND CHARGING PATTERNS

APPENDIX A-I. DATA CLEANING AND PREPARATION

APPENDIX A-I.I. PARTICIPANT DATA

The team relied on participant data extracts provided by PGE. Data we received included vehicle/charger enrollment and unenrollment records starting in 2020. Each record contained associated customer information, enrollment dates, unenrollment dates (where applicable), EV and charger information, and group designation, among other data fields. As part of the data cleaning process, we reconciled participant charger and EV counts and IDs, reviewed, and eliminated duplicate records, and addressed gaps, missing, and unreasonable values, where possible and feasible. We transformed the data, so it was at the vehicle level for evPulse participants and the charger level for EVSE participants. Finally, we verified the accuracy of the customer program enrollment date, merged in TOD and PTR enrollment information, and identified EV types using the available EV make information and post-event survey information, where applicable.

APPENDIX A-I.II. CHARGING DATA

The EVSE telemetry data contained charger-level hourly interval load data. As part of the EVSE data cleaning, we reviewed the data for duplicate records, identified missing records and imputed data when possible, corrected outlier records, and removed participant days with insufficient data.[32] Additionally, the charging interval data provided for EVSE participants in the Winter 2022/2023 Event Season was provided in Watts rather than kW, so an additional step was added to convert the data to kW. Finally, the Group B December file was provided with all records recorded as negative, which we also adjusted.

The evPulse vehicle telemetry data contained vehicle-level 15-minute interval load data. As part of the data cleaning, we reviewed the data for duplicate records, imputed missing records, aggregated the data to an hourly level, and fixed outlier records. The data was similarly scrutinized for participant days with less than 24 hours of interval data.

Table 34 summarizes cleaning steps, by season, made to each charging data source as part of the data preparation and cleaning process. After initial cleaning, we filtered the data to include relevant participants and days, per season. PTR days were excluded from the analysis. In cases of a charger changeover, interval data was combined across the two chargers, however, in cases of a vehicle changeover the interval data was kept separate. This led to a few discrepancies between the participation data and the impact data. For equivalency, modeling, and opt-out analysis purposes, we required that participants have data for 75% of a season's days. We dropped records with insufficient data across the relevant event season.

[32] Imputations were conduct for missing data. If an entire hour was missing, 0 consumption was imputed for that hour. If an interval within an hour was missing, then the average of the other observations in that hour were used for imputation.

Table 34. Residential Charging Pilot Charging Data Cleaning Steps

Drop Reason	Winter 2021/2022		Summer 2022		Winter 2022/2023	
	Vehicles/Chargers	Observations	Vehicles/Chargers	Observations	Vehicles/Chargers	Observations
EVSE						
Initial Count	587	1,961,699	977	3,401,286	1,270	4,685,677
Drop Exact Duplicates	587	1,790,510	977	3,277,593	1,270	4,685,677
Fix Imperfect Duplicates	587	1,788,147	977	3,277,574	1,270	4,685,677
Imputation	587	1,788,710	977	3,285,614	1,270	4,689,205
Outlier Fix	587	1,788,710	977	3,285,614	1,270	4,689,205
<24 Hours of interval data	587	1,783,536	977	3,274,560	1,270	4,683,000
evPulse						
Initial Count	516	351,188	498	846,348	1,312	1,282,369
Drop Exact Duplicates	516	351,188	498	729,286	1,312	1,282,369
Fix Imperfect Duplicates	516	351,188	498	729,286	1,312	1,282,369
Imputation	516	3,662,096	498	7,924,622	1,312	14,785,289
Roll up to an hour	516	936,790	498	2,021,914	1,312	3,767,933
Outlier Fix	516	936,790	498	2,021,914	1,283	3,745,584
<24 Hours of interval data	510	926,616	486	2,012,616	1,283	3,745,584

The available data had several limitations. The EVSE charger telemetry data was missing for Group A for October 2021. As a result, we excluded October 2021 from the impact analysis. The initial counts in the above table reflect the exclusion of October. Additionally, we found other missing data across groups, usually the last few days or hours of a month. We determined that the small amount of missing data would not greatly impact results and used all available data for each period when modeling savings and charging patterns.

APPENDIX A-II. EVENT DEMAND IMPACTS

Our impact analysis included an equivalency analysis and estimating the impact of the pilot on EV charging load during each group's event period. Below, we outline analytical activities and key results that were a part of the analysis.

APPENDIX A-II.I. EQUIVALENCY ANALYSIS

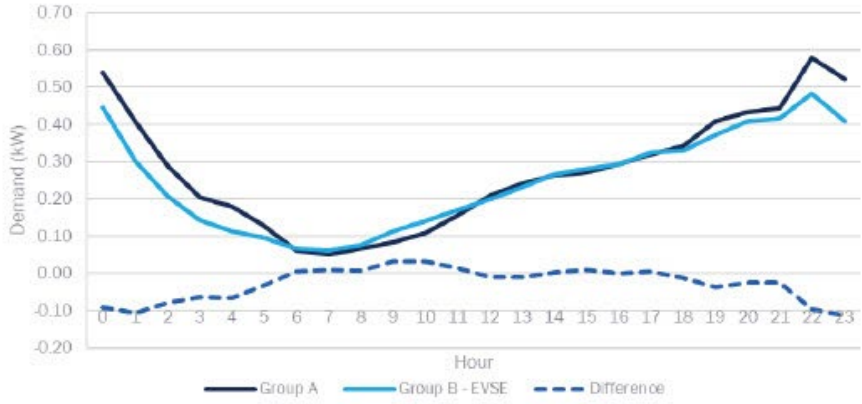
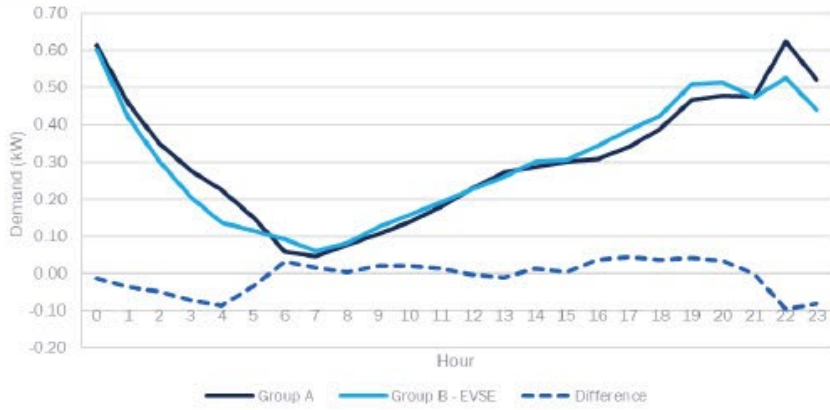
To validate the fidelity of the pseudo-experimental design, the team conducted an equivalency analysis. Due to the pilot design, there are no weekdays (non-holidays) in the event season where charging was not curtailed during event hours for treatment groups. Additionally, there was minimal pre-period data available for participants. Therefore, the team is limited by the lack of untreated days in which to conduct an equivalency analysis between the control group and the treatment groups.

Due to this lack of data, the team used weekend load shapes to evaluate equivalency. The use of weekends is an imperfect approach for several reasons. First, weekend energy use may differ between the treatment and control groups due to the pilot, as events called among treatment customers during the week may impact their charging behavior on the weekend, even though there are no curtailment events on the weekend. Second, weekend charging

behavior may be different from weekday charging for many customers, which means that we assessed equivalency using days that may be different from event days. This reduces our confidence that the differences in treatment and control group charging behavior on event days are due to the pilot alone.

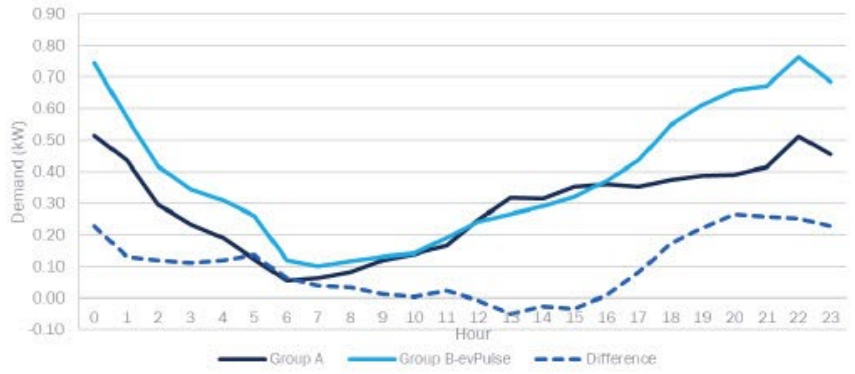
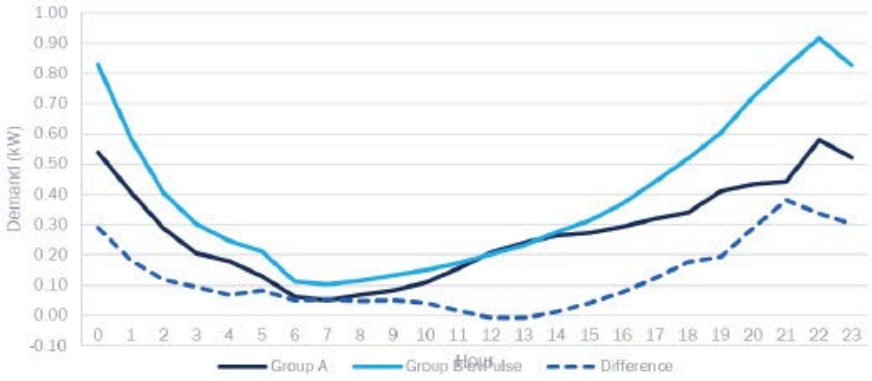
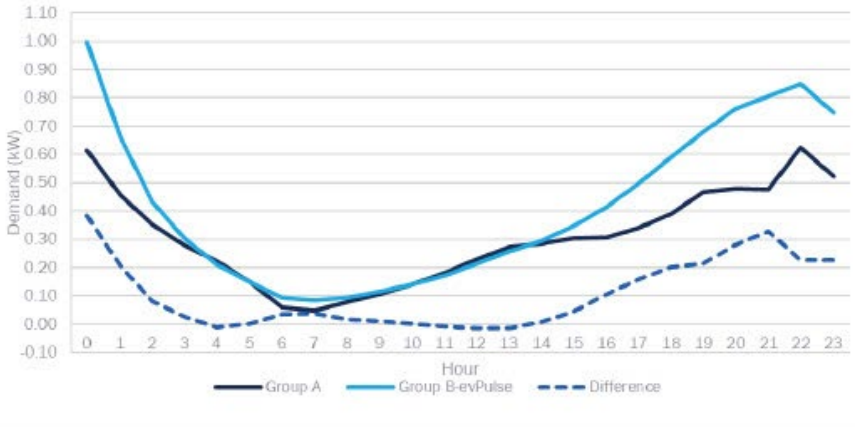
Weekend and holiday load shapes illustrate charging patterns without load control for the treatment groups compared to the control group (Figure 45). The difference between the groups is also graphed as the dashed line. The weekend/holiday load shapes are an imperfect metric for equivalency, but they do provide some indication of charging pattern. In general, Group B and Group A weekend/holiday load shapes are relatively similar in trend and magnitude. This is also true for Group C; Group C has a larger separation in the morning hours which is likely due to the spillover of weekday charging or charging schedules. For example, on Friday evening when a vehicle is curtailed from 10-12, this charging may be completed on Saturday morning. Alternatively, participants may program chargers for event purposes and do so for seven days a week despite the events only being in effect on weekdays. This does not occur for Group A, since this group does not have charging curtailed. After the morning hours, the control and treatment Group C are very similar. We see a much larger separation in charging load between Group B evPulse and Group A in magnitude.

Figure 45. Weekend and Holiday Load Shape Equivalency Analysis between Group A and Group B (EVSE) by Season

Group B EVSE Winter 2021/2022	
Group B EVSE Summer 2022	
Group B EVSE Winter 2022/2023	

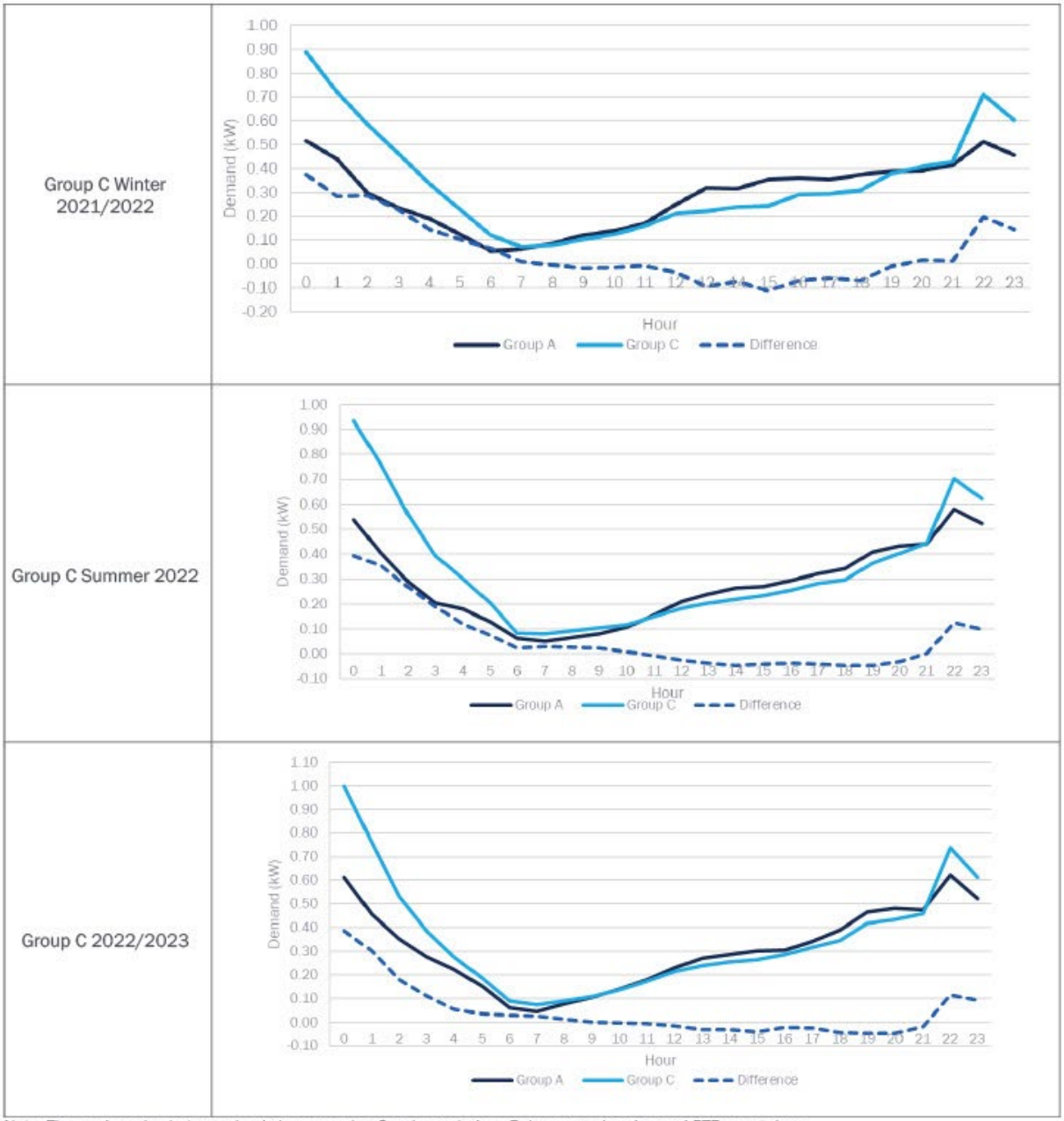
Note: The y-axis varies between load shape graphs. Graphs exclude evPulse away charging and PTR event days.

Figure 46. Weekend and Holiday Load Shape Equivalency Analysis between Group A and Group B (evPulse) by Season

Group B evPulse Winter 2021/2022	
Group B evPulse Summer 2022	
Group B evPulse Winter 2022/2023	

Note: The y-axis varies between load shape graphs. Graphs exclude evPulse away charging and PTR event days.

Figure 47. Weekend and Holiday Load Shape Equivalency Analysis between Group A and Group C by Season



Note: The y-axis varies between load shape graphs. Graphs exclude evPulse away charging and PTR event days.

There are multiple factors that may be contributing to the inequivalences between Group B evPulse and Group A. Vehicles in Group B evPulse have a higher average daily EV charging consumption and hourly demand compared to the control group. Table 35 shows average consumption and demand per vehicle/charger per day (kWh) and per hour (kW).

Group B evPulse has 25% to 35% higher per vehicle/charger average daily consumption and hourly demand compared to the control group across all seasons.

Table 35. Average Consumption and Demand per Vehicle/Charger, by Season evPulse and Group A

Group/ Season	Average Consumption per Vehicle/Charger per Day (kWh)	Average Consumption per Vehicle/Charger per Hour (kW)
Winter 2021/2022		
Group A	6.94	0.29
Group B (evPulse)	8.76	0.37
Summer 2022		
Group A	6.47	0.27
Group B (evPulse)	8.71	0.36
Winter 2022/2023		
Group A	7.29	0.30
Group B (evPulse)	9.34	0.39

Note: Summaries exclude evPulse away charging and PTR event days.

In addition, the team explored participant characteristics that may impact charging across the groups. Key characteristics include enrollment in a TOD rate across all groups, and specific to EVSE participants, the number of EVs per home, and the EV type. We anticipate that these characteristics may impact a customer's charging load.

Another key difference between the two groups is the unit of observation. The unit of observation for Group A is the charger, while the unit of observation for Group B evPulse is the EV itself, therefore it is not a like-to-like comparison.

Another notable difference between the groups, and potentially the largest piece of discrepancy, is the composition of EV types; evPulse only includes Tesla vehicles, which are all BEVs, while Group A also includes PHEV vehicles. However, even controlling for EV type in Group A, evPulse had higher usage values relative to Group A BEVs (breakdowns are included in the charging pattern analysis section of the report).

Another area where the evPulse channel differs from the EVSE channel is the control strategy used. Participants enrolled in evPulse are enrolled in a dynamic optimization program. WeaveGrid shared that they encourage participants to have their car plugged in as much as possible and encourages them not to set a schedule on their charger (this could interfere with the optimization). Additionally, evPulse does not throttle charging as a part of optimization. The start and stops of charging are optimized but when the vehicle is charging, it is at the full capacity of the charger. The optimized schedule of charging is developed based on three attributes:

- Driver needs and preferences – this is the first and most influential attribute and is driven by the charge-ready time selected by the participant.
- TOU and TOD rate – the driver's electricity cost is the next most important factor in determining optimized charging times.
- PGE DR event window - is the third factor considered when optimizing charging.

Optimization occurs whenever a vehicle is plugged in at home (aside from in the case of technological issues), which includes weekends.

The evaluation team deemed that the control group and treatment Group B (EVSE) and Group C were equivalent enough to model impacts but that the evPulse participants did not have required representation in the control group to be considered equivalent.

APPENDIX A-II.II. LOAD IMPACTS: SIMPLE DIFFERENCES

As a beginning step in the analysis, the team compared the hourly load values on the average event day of the control group with the treatment groups to roughly estimate the kW savings of the average event. For each treatment group (i.e., Groups B-EVSE, B-evPulse, and C), the team estimated hourly kW demand impacts on a per-vehicle level for the evPulse participants and a per-charger level for the EVSE participants on the average event day. To determine the demand impacts, the team subtracted the mean charging demand (kW) during the event hours of the control group (Group A) from the treatment groups. Away charging for evPulse participants was excluded from this analysis. Separate analyses were conducted for each event season. This analysis does not adequately control for the time-invariant characteristics of participants, as our modeling impact analysis does.

Table 36 presents the impact results leveraging a simple difference approach compared to the modeled approach. The straight difference approach is relatively in line with the modeled results. Notably, the model generates separate outputs for TOD and non-TOD participants in Group C for the Winter 2022/2023 Event Season; these groups are not separated when calculating straight differences. To make these approaches comparable, the team applies a weighted average to the modeling approach for the Winter 2022/2023 Event Season to generate an overall impact for Group C. We include evPulse in this straight difference exploration despite removing them from modeled results.

Table 36. Average Performance by Event Season

Season	Group	Straight Difference: Average Hourly Demand Impact per Charger/Vehicle (kW)	Modeled: Average Hourly Demand Impact per Charger/Vehicle (kW)
Winter 2021/2022	Group B (EVSE)	0.29	0.27
	Group B (evPulse)	0.23	
	Group C (EVSE)	0.50	0.48
Summer 2022	Group B (EVSE)	0.27	0.27
	Group B (evPulse)	0.22	
	Group C (EVSE)	0.56	0.51
Winter 2022/2023	Group B (EVSE)	0.24	0.34
	Group B (evPulse)	0.25	
	Group C (EVSE)	0.55	0.62*

Note: Excludes evPulse away charging and PTR event days.
* Weighted average of Group C and Group C TOD

APPENDIX A-II.III. LOAD IMPACTS: FIXED EFFECTS MODEL

We used fixed effects linear regression modeling to develop event season demand impacts, with the fixed effect set at the charger/vehicle level. We incorporated fixed effects terms to control for time-invariable, unobservable factors affecting demand (i.e., factors that do not change over the study period, such as the power draw of the vehicle) without measuring those factors explicitly in the models. The model estimated the hourly kW demand impacts on a per-vehicle/EVSE level. EVSEs assigned as control were used to construct baseline or counterfactual load. Since events were called daily on weekdays during each season, event impacts were not calculated per event, but in aggregate for each event season across all events.

Notably, we did not model evPulse participants due to the lack of a representative control group. Event impacts were calculated as the mean difference between the modeled (predicted) baseline kW and the modeled (predicted) event kW over the event period. Despite low r-squared values, the modeled results are reasonable and statistically significant,

with similar savings values to the average difference-in-difference results we calculated. The low r-squared values may be due to the variability and high frequency of zeros in the interval data.

As is standard practice for impact analyses, we tested several different model specifications before selecting the best model. We also tested several models controlling for EV type. See below for model specifications and model fit outputs chosen by season and group.

Additionally, we estimated TOD event impacts for Group C Winter 2022/2023 since a large percentage of the Group C participations in the Winter 2022/2023 Event Season were also on a TOD rate. The team does not report TOD event impacts for Winter 2021/2022 or Summer 2022, however, because the model results showed that impacts were not statistically significant during event hours. This is likely due to the low number of TOD customers in Group A for Winter 2021/2022 and Summer 2022 which, after cleaning, did not allow the model to fully capture the consumption variation for these vehicles.

We calculated the average event impact by multiplying the per-charger per event modeled impacts by the number of chargers enrolled as of the end of the event season per group. This value does not represent realized event-season demand savings for each event. There is rolling enrollment in the pilot and not all participants who are enrolled at the end of the event season were enrolled for every event day of that season.

Model Specification

Equation 1 shows the model specification used to develop event hour impacts for EVSE vehicles in Group B for the Winter 2021/2022, Summer 2022, and Winter 2022/2023 Event Seasons and Group C for the Winter 2021/2022 and Summer 2022 Event Seasons. The fixed effect was specified at the EVSE vehicle level.

Equation 1. Residential Charging Pilot Event Hour Impact Model Specification for Group B All Event Seasons and Group C Winter 2021/2022 and Summer 2022 Event Seasons

$$kW_{it} = \alpha_i + \sum_{t=Event\ Start}^{Event\ End} \beta_{Treatment \cdot Event\ Hour} \cdot Treatment_i \cdot Event\ Hour_t + \sum_{t=Deferred\ Charging\ Start}^{Deferred\ Charging\ End} \beta_{Treatment \cdot Deferred\ Charging} \cdot Treatment_i \cdot Deferred\ Charging\ Hour_t + \sum_{t=0}^{23} \beta_{Hour_t} \cdot \mathrm{Hour_t} + \varepsilon_{it}$$

Where:

α_i = EVSE vehicle-specific intercept
$Treatment_i$ = Indicator variable for treatment customers for EVSE vehicle *i*
$Deferred\ Charging\ Hour_t$ = Indicator variable for deferred charging after demand response event (5 hours after the event) for time-period *t*
$Event\ Hour_t$ = Indicator variable for Group B event hours (3 hours) for time-period *t*
$Hour_t$ = Set of 23 indicator variables for hours of the day
ε_{it} = Error term

Equation 2 shows the model specification used to develop event hour impacts for EVSE vehicles in Group C for the Winter 2022/2023 Event Season. The fixed effect was specified at the EVSE vehicle level.

Equation 2. Residential Charging Pilot Group C Event Hour Impact Model Specification for Winter 2022/2023 Event Season

$$kW_{it} = \alpha_i + \sum_{t=Event\ Start}^{Event\ End} \beta_{Treatment \cdot Event\ Hour} \cdot Treatment_i \cdot Event\ Hour_t + \sum_{t=Event\ Start}^{Event\ End} \beta_{Treatment \cdot Event\ Hour \cdot TOD} \cdot Treatment_i \cdot Event\ Hour_t \cdot TOD_i + \sum_{t=Event\ Start}^{Event\ End} \beta_{Event\ Hour \cdot TOD} \cdot Event\ Hour_t \cdot TOD_i + \sum_{t=Deferred\ Charging\ Start}^{Deferred\ Charging\ End} \beta_{Treatment \cdot Deferred\ Charging} \cdot Treatment_i \cdot Deferred\ Charging\ Hour_t + \sum_{t=Deferred\ Charging\ Start}^{Deferred\ Charging\ End} \beta_{Treatment \cdot Deferred\ Charging \cdot TOD} \cdot Treatment_i \cdot Deferred\ Charging\ Hour_t \cdot TOD_i + \sum_{t=0}^{23} \beta_{Hour_t} \cdot Hour_t + \varepsilon_{it}$$

Where:

α_i = EVSE vehicle-specific intercept
$Treatment_i$ = Indicator variable for treatment customers for EVSE vehicle *i*
$Deferred\ Charging\ Hour_t$ = Indicator variable for deferred charging after demand response event (5 hours after the event) for time-period *t*
$Event\ Hour_t$ = Indicator variable for Group C event hours (2 hours) for time-period *t*
$Hour_t$ = Set of 23 indicator variables for hours of the day
TOD_i = Indicator variable for TOD customers for EVSE vehicle *i*
ε_{it} = Error term

Model Outputs

Table 37 summarizes load impacts by season for each hour of the event for Group B (three event hours).

Table 37. Residential Charging Pilot Group B Summary of Hourly Per Season Load Impacts

Season	Hour	Modeled Baseline Load (kW)	Demand Impact (kW)	% Demand Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
Winter 2021/2022	17	0.34	0.25	74%	0.04	0.18	0.32
	18	0.39	0.29	75%	0.05	0.20	0.37
	19	0.41	0.28	68%	0.06	0.17	0.39
Summer 2022	17	0.29	0.23	82%	0.03	0.18	0.29
	18	0.32	0.27	85%	0.03	0.22	0.33
	19	0.36	0.31	86%	0.04	0.24	0.37
Winter 2022/2023	17	0.40	0.30	76%	0.04	0.24	0.36
	18	0.45	0.35	76%	0.04	0.28	0.41
	19	0.48	0.37	77%	0.05	0.29	0.45

Table 38 summarizes load impacts by season for each hour of the event for Group C (two event hours).

Table 38. Residential Charging Pilot Group C Summary of Hourly Per Season Load Impacts

Season	Hour	Modeled Baseline Load (kW)	Demand Impact (kW)	% Demand Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
Winter 2021/2022	22	0.67	0.55	81%	0.11	0.38	0.73
	23	0.59	0.41	70%	0.08	0.28	0.56
Summer 2022	22	0.63	0.51	80%	0.07	0.38	0.62
	23	0.64	0.50	79%	0.08	0.36	0.60
Winter 2022/2023	22	0.61	0.44	72%	0.08	0.32	0.57
	23	0.55	0.38	70%	0.07	0.27	0.49

Table 39 summarizes load impacts by season for each hour of the event for Group C TOD (two event hours) for the Winter 2022/2023 Event Season. TOD load impacts are not being reported for summer 2022 and Winter 2021/2022 because model results showed that load impacts were not statistically significant during event hours. This is likely due to the low number of TOD customers left in Group A and C after cleaning for Summer 2022 and Winter 2021/2022 which did not allow the model to fully capture the consumption variation in these customers.

Table 39. Residential Charging Pilot Group C – TOD Summary of Hourly Winter 2022/2023 Load Impacts

Season	Hour	Modeled Baseline Load (kW)	Demand Impact (kW)	% Demand Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
Winter 2022/2023	22	1.18	0.89	75%	0.26	0.46	1.31
	23	0.93	0.63	68%	0.30	0.14	1.12

Table 40 shows the model fit statistics of the final chosen model for each Group and Season.

Table 40. Residential Charging Pilot Summary of Model Fit Statistics by Group and Season

Season	Adjusted R squared	P Value	Number of Vehicles
Group B (EVSE)			
Winter 21/22	0.05	0.00	207
Summer 22	0.05	0.00	287
Winter 22/23	0.05	0.00	371
Group C			
Winter 21/22	0.04	0.00	211
Summer 22	0.05	0.00	441
Winter 22/23	0.06	0.00	697

APPENDIX A-III. OPT-OUT ANALYSIS

To understand event performance, the team conducted an analysis of participant opt-outs. We received connectivity data from Generac for the EVSE channel. Our review of that data revealed gaps and suspicious patterns, suggesting the data was unreliable. Generac was unable to supply additional data for the pilot's first three event seasons but did provide data from the Summer 2023 season, which we will explore as part of the 2024 evaluation.

WeaveGrid provided data on customer opt-outs based on several criteria. According to WeaveGrid, when a participant plugs in at home, they automatically have an optimized charging schedule set. The participant has the option to opt-out/override that schedule by selecting to "Charge Now" in a variety of ways, via SMS, the evPulse app or Tesla app, or through the charger if a customer has a smart charger. If a participant chooses to charge, they will charge until the charge is completed or the vehicle is unplugged, and they will not receive additional notice when it is a DR event. Through this definition, WeaveGrid may flag participants as an opt-out if they override a scheduled charge even if it did not lead to charging during the PGE event hours.

However, there may also be cases where WeaveGrid does not flag charging as an opt-out, despite the vehicle charging during the event. There are a few reasons for this.

- The first is insufficient slack. This occurs when a vehicle's ready-by-time requires the vehicle to charge during PGE event hours. In these cases, participants do not opt out of optimization because their optimized schedule was to charge during the event.
- The next is low battery protection. Some customers can select to have low battery protection, this means that whenever they plug in their car, if the state of charge is below 20% the car will charge immediately until it reaches that 20% level and then will begin optimized charging. The participant is not opt-outing out of optimization, so it is not flagged as an opt-out despite charging through an event.
- WeaveGrid also identified that there are cases where an optimized schedule fails to deliver to a participant, which may contribute to charging through events, but these would not be recorded as opt-outs because the participant did not intentionally opt-out of the charging schedule. In these cases, WeaveGrid notifies the customer of the error.

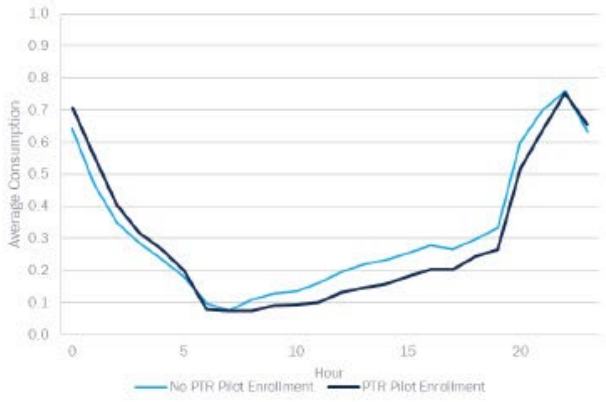
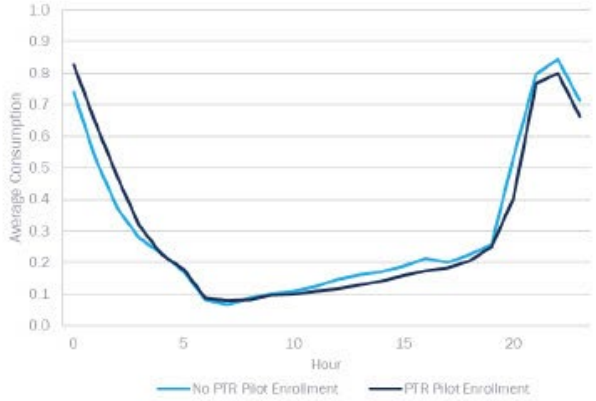
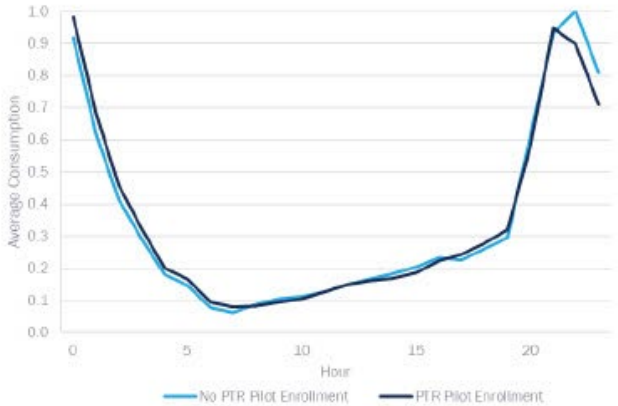
To be consistent across the two channels, for this evaluation, the team defined an event opt-out as participants that have greater than zero consumption during at least one hour of their PGE event window. For evPulse, away charging is excluded from this exploration since charging is not curtailed when the vehicle is not at home. We received hourly data for the EVSE channel and 15-minute data for evPulse. Given the level of data aggregation, we cannot identify customers who charged for just a few minutes. In future analyses, we could explore setting a minimum amount of charging during the hour to be classified as an opt-out.

As part of the 2024 evaluation, if connectivity data are reliable, we will explore event failures vs opt-outs. This exploration will help determine whether instances of event nonperformance can be attributed to technology and event execution issues or customer behavior.

APPENDIX A-IV. ADDITIONAL CHARGING PATTERN COMPARISONS

To explore participant charging patterns, we developed average hourly electricity consumption load curves for different customer segments and day types for each event season. We report on many of these segments in the body of the report and provide additional load shapes in this section for customers who participated in the PTR Pilot, and for evPulse participants, charging at home versus away from home.

Figure 48. Average Hourly Demand by Group, Event Season by PTR

Winter 2021/2022	
Summer 2022	
Winter 2022/2023	

The inclusion of away charging increases average hourly demand during the middle of the day, including during evPulse event hours. Since evPulse leverages vehicle telematics, we received EV charging interval data for charging at home and away from home ("away"). Average daily charging load at home only vs. at home and away are presented in Figure 49,

Figure 50, and

Figure 51. Participants enrolled in evPulse have different charging habits when charging away from home, the average hourly consumption peak occurs in the middle of the day relative to overnight that is observed in home charging. Notably, evPulse vehicles are not optimized when charging away from home.

Figure 49. Average Hourly Demand by Plug location – Winter 2021/2022

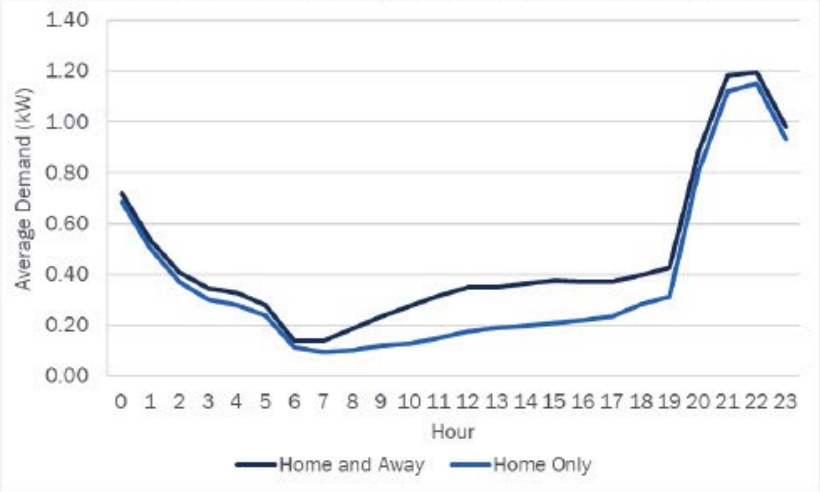


Figure 50. Average Hourly Demand by Plug location – Summer 2022

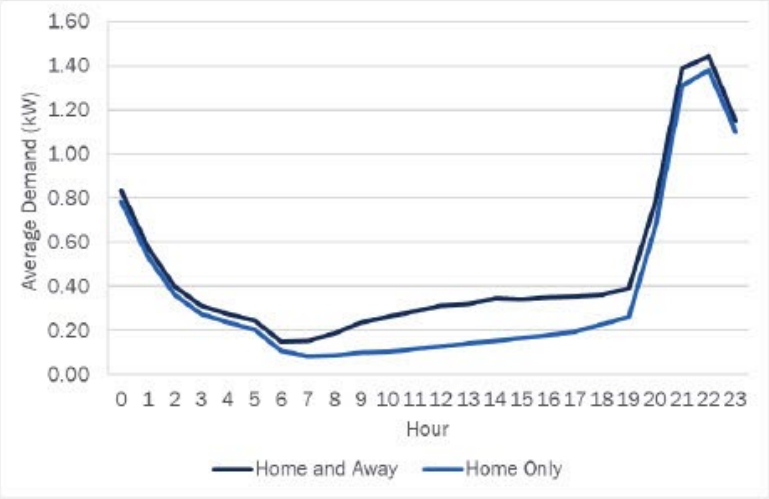
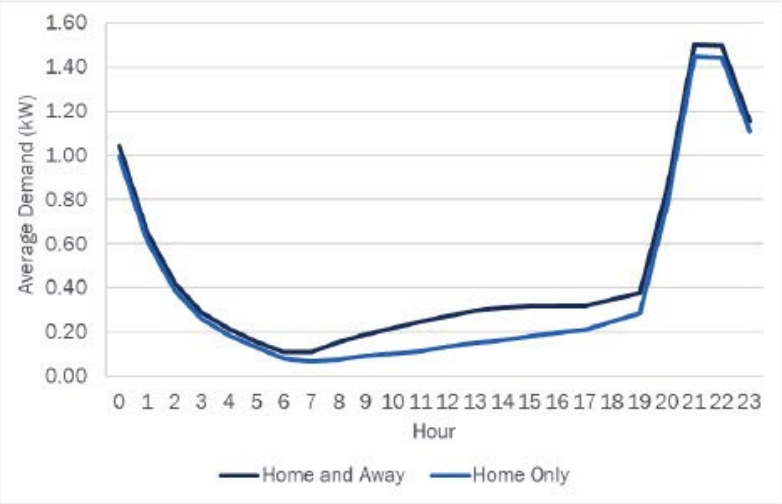


Figure 51. Average Hourly Demand by Plug location – Winter 2022/2023



APPENDIX A-V. PEAK PERIODS

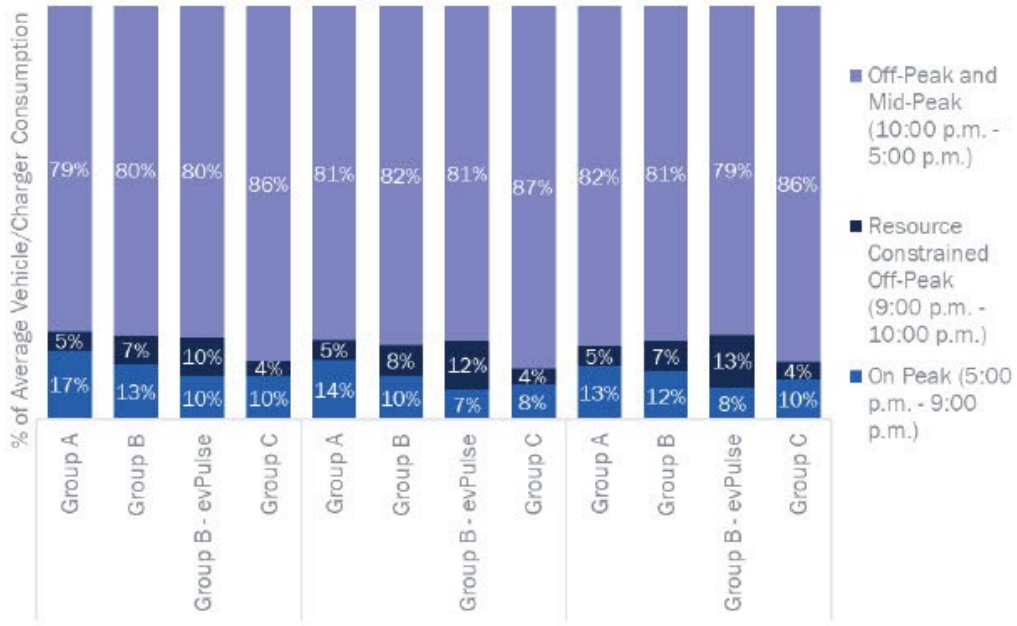
Figure 52 illustrates the percent of charging consumption by hour type for each Pilot group. Charging is broken down by on-peak (5:00 p.m.–9:00 p.m.), resource constrained off-peak (9:00 p.m.–10:00 p.m.), and off-peak/mid-peak (9:00 p.m.–5:00 p.m.).[33] The resource constrained hour is a period of time identified in PGE's IRP resource constraint model where there is high likelihood of future energy supply gaps. The resource constrained hour from 9:00 p.m. to 10:00 p.m. is not included in any of the event windows. Group B's window ends at 8:00 p.m. and the management of Group C does not begin until 10:00 p.m..

[33] Peak periods are defined based on PGE's residential TOD plan: https://portlandgeneral.com/about/info/pricing-plans/time-of-day.

Group B evPulse had the lowest percentage of on-peak consumption, however, it has the highest percent of charging during the off-peak resource constrained hour from 9:00 p.m. to 10:00 p.m., which is the beginning of off-peak for TOD.

Group C, which also has a higher percentage of TOD participants, has the second lowest usage during on-peak hours, but also the lowest share of consumption during the resource constrained hour. This pattern suggests that participants are shifting their charging overnight rather than earlier in the day to accommodate both TOD and their event window from 10:00 p.m. to 11:59 p.m.

Figure 52. Residential Percent Consumption by Hour Type and Group



Note: Excludes evPulse away charging and PTR event days.

APPENDIX B. BUSINESS CHARGING REBATES PILOT: IMPACT ANALYSIS METHODS AND CHARGING PATTERNS

APPENDIX B-I. CHARGING DATA CLEANING AND PREPARATION

Time Series Verification

The evaluation team verified the time series construction conducted by PGE. In doing so, we identified a small percentage of misalignment between the session and the constructed time series data. We concluded that the issues would not greatly impact results and the time series data was usable for the charging pattern analysis. Table 41 summarizes the steps and findings from our verification process.

Table 41. Business Charging Rebates Pilot Time Series Data Verification

Drop Reason	# of Sessions	% of Sessions Impacted	Comments
Initial Count	27,449	100%	Total number of unique sessions
Start times do not align	33	0.1%	In all cases, this was due to missing charging start information, preventing time series data creation for this session.
End times do not align	71	0.3%	In 33 cases, this was due to missing end-time information (same cases as above). Most cases were less than one hour different.
Durations do not align	1,640	6.0%	In some cases, the vendor-provided charging start and end time did not align with the provided charge duration. Given that the time series data is generated from charge start and end, we recalculated the charge duration to align with the start and end times. This reduced the count to 63 sessions (this includes the 33 cases with missing information).
The energy consumed does not align	63	0.2%	This includes the 33 cases with missing information because the missing end-time was required for the generation of the time series data. Therefore, in these cases, the constructed data has an energy consumption of 0.
Count of records that do not align	56	0.2%	This includes the 33 cases with missing information because the missing end-time was required for the generation of the time series data. Therefore, in these cases, the constructed data has a record count of only one despite the session length.

Session Data

The evaluation team relied on the comprehensive data extraction provided by PGE for session data. Since the same file was used for time series reconstruction which led to the duplication of sessions, we filtered the data to only session-level information and removed any duplicates to apply cleaning steps to the session data. As part of the session data cleaning, we reviewed the data for duplicate records, addressed gaps and conflicting information (where possible and reasonable), and subset the data to the relevant reporting period (pilot start through August 2023).

Table 42 summarizes cleaning steps made to the session data set as part of the data preparation and cleaning process. The cleaned session data is then used to update the time series data.

Table 42. Business Charging Rebates Pilot Session Data Cleaning Steps

Step	Type	Update/Drop	Remaining Unique Session IDs	Percent Remaining
Initial Count	NA	NA	27,449	100%
Invalid plug start and end times	Drop	3	27,446	100%
Missing charge start and end times	Drop	33	27,413	99.9%
Invalid charge start and end times	Drop	1	27,412	99.9%
Updating plug start times to align with charging start times	Update	1,878	27,412	99.9%
Updating plug end times to align with charging end times	Update	2	27,412	99.9%
Sessions with 0 seconds between plug start and end	Drop	44	27,368	99.7%
Sessions with 0 seconds between charging start and end	Drop	1,600	25,768	93.9%
Sessions with 0 consumption	Drop	120	25,648	93.4%
Subset data to the relevant time period	Drop	749	24,899	90.7%

Time Series Data

The cleaned session data was used to update the time series data. Sessions that were dropped in session data cleaning were also eliminated from the time series data, and any updated session information was applied to the time series data. Exact duplicates were also dropped. No cleaning was conducted on the charging start and end dates, so reconstruction of the data was not required. Once the time series data was updated, it was then aggregated to an hourly level, missing records were imputed, and the data was subset to the relevant reporting period. Days missing 24 hours of interval data were removed from the analysis.

APPENDIX B-II. CHARGING PATTERN ANALYSIS

Figure 53 - Figure 55 present additional average hourly electricity consumption load curves by segments and day types.

Figure 53. Business Charging Rebates Pilot Average Load Shapes per Day Type

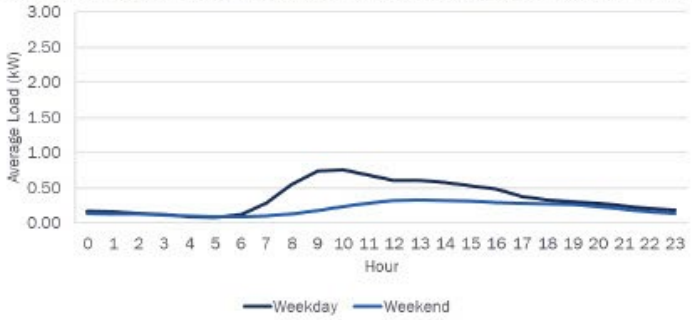


Figure 54. Business Charging Rebates Pilot Average Load Shapes per Customer Type

Figure 55. Business Charging Rebates Pilot Average Load Shapes per Rate

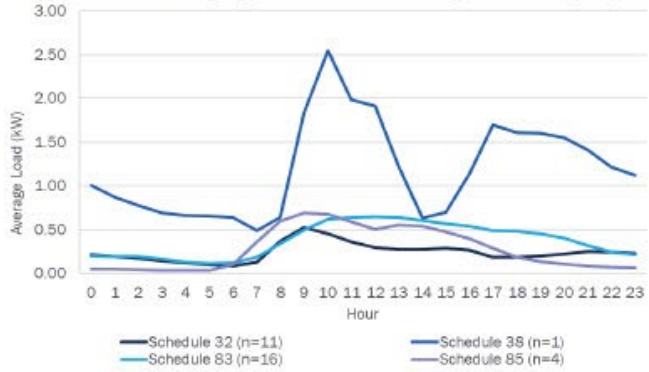


Table 43 presents the Business Charging Rebates Pilot participation data per customer through the end of August 2023.

Table 43. Business Charging Rebates Pilot Participation by Customer

Customer	Customer Type	Number of Sites	Number of Chargers	Chargers with Data
200046	Public/Government Entity	1	4	4
200049	Public/Government Entity	1	8	8
200050	For-Profit Company	1	2	1
200051	For-Profit Company	1	8	6
200052	For-Profit Company	1	2	1
200053	Public/Government Entity	2	3	3
200054	For-Profit Company	1	2	No data
200055	Public/Government Entity	1	1	1
200056	Non-Profit Organization	1	2	2
200057	For-Profit Company	5	6	5
200058	Public/Government Entity	1	9	9
200059	For-Profit Company	1	6	6
200060	Public/Government Entity	2	4	4
200061	Non-Profit Organization	1	1	No data
200062	Public/Government Entity	1	4	4
200063	For-Profit Company	1	8	8
200064	Non-Profit Organization	1	1	No data
200428	For-Profit Company	2	4	4
200448	For-Profit Company	1	2	1
201362	Public/Government Entity	4	5	4
201375	Non-Profit Organization	3	6	5
201376	Non-Profit Organization	1	1	1
201622	For-Profit Company	1	2	1
201623	For-Profit Company	2	12	No data
201776	Non-Profit Organization	1	4	No data
201777	For-Profit Company	1	3	No data
201806	For-Profit Company	1	3	3
201807	For-Profit Company	1	4	No data
201936	Non-Profit Organization	1	21	1

Table 44 presents the session summaries of the Business Charging Rebates Pilot participants per site through the end of August 2023.

Table 44. Business Charging Rebates Pilot Session Summaries by Site

Site	Use	Number of Sessions	First Charge	Last Charge	Average Charge Duration	Average Session Duration	Average Electricity Dispensed
100037	Fleet, Workplace, Public	1,045	8/19/2021	8/31/2023	2.14	2.62	11.21
100039	Public	73	4/4/2023	8/6/2023	3.35	5.57	18.10
100026	Fleet, Workplace, Public	1565	4/21/2022	8/31/2023	2.06	5.04	7.70
100024	Fleet, Workplace, Public	5626	3/29/2021	8/31/2023	3.40	5.85	14.84
100032	Multifamily	223	12/31/2020	8/31/2023	3.95	12.62	31.74
100031	Fleet, Workplace, Public	754	7/16/2021	8/31/2023	2.28	3.28	8.93
100034	Fleet, Workplace, Public	2760	8/5/2021	8/31/2023	1.97	2.23	8.79
100035	Fleet, Workplace, Public	1297	8/3/2021	8/31/2023	1.98	2.51	8.91
100038	Fleet, Multifamily, Workplace, Public	6786	9/5/2021	8/31/2023	2.78	5.77	13.58
100036	Fleet, Workplace, Public	557	8/17/2021	8/31/2023	1.79	2.05	7.72
100028	Public	859	11/23/2021	9/1/2023	4.52	5.79	23.32
100029	Public	330	11/23/2021	8/16/2023	3.73	4.49	23.22
100027	Fleet, Workplace, Public	64	1/25/2023	8/9/2023	2.52	3.36	17.53
100025	Workplace	496	3/29/2022	8/30/2023	3.66	6.46	19.64
100033	Fleet, Workplace, Public	249	8/31/2021	8/29/2023	1.61	1.83	8.46
100043	Fleet, Workplace, Public	980	4/3/2023	9/1/2023	2.07	2.44	10.11
100040	Workplace, Public	39	4/5/2023	8/31/2023	2.43	10.19	8.94
100041	Workplace, Public	98	4/3/2023	8/31/2023	3.91	5.11	15.93
100044	Workplace	393	4/1/2023	9/1/2023	3.68	5.01	16.49
102189	Public	19	7/9/2023	8/30/2023	2.32	2.98	12.20
102194	Public	3	7/11/2023	8/17/2023	0.79	1.49	4.06
102191	Public	15	7/24/2023	8/31/2023	1.74	1.82	9.08
103052	Multifamily	50	8/1/2023	9/1/2023	1.81	1.94	9.21
100648	Public	26	4/3/2023	8/24/2023	2.03	2.31	13.70
100645	Public	260	4/1/2023	8/30/2023	1.20	1.48	6.84
102773	Public	3	8/16/2023	8/30/2023	1.59	1.66	9.64
102193	Public	47	7/6/2023	8/31/2023	2.69	2.80	16.27
102192	Public	2	8/3/2023	8/16/2023	2.55	2.55	14.87
102197	Public	6	7/6/2023	8/27/2023	2.07	2.95	10.58
102195	Multifamily	13	7/3/2023	8/29/2023	3.14	3.35	32.95
100010	Fleet	243	5/31/2023	9/1/2023	12.09	15.19	45.07
103364	Multifamily	1	8/31/2023	9/1/2023	6.43	16.95	42.02
100649	Multifamily	16	7/1/2023	8/30/2023	4.72	8.83	16.06

Table 45 presents the energy consumption summaries of the Business Charging Pilot participants per site through the end of August 2023.

Table 45. Business Charging Rebates Pilot Energy Consumption per Site

Site	Total Consumption	Average Number of Ports	Off Peak %	On Peak %	Rate	Site Use
100010	10,476	4	32%	68%	Schedule 38	Fleet
103052	357	4	74%	26%	Schedule 83	Multifamily
100648	277	2	71%	29%	Schedule 83	Public
100645	1,699	2	68%	32%	Schedule 83	Public
102197	18	2	59%	41%	Schedule 83	Public
100043	9,753	4	40%	60%	Schedule 83	Fleet; Workplace; Public
100038	91,597	14	32%	68%	Schedule 83	Fleet; Multifamily; Workplace; Public
102189	183	2	28%	72%	Schedule 83	Public
100036	4,279	2	23%	77%	Schedule 83	Fleet; Workplace; Public
100027	1,106	1	22%	78%	Schedule 83	Fleet; Workplace; Public
100034	24,180	2	21%	79%	Schedule 83	Fleet; Workplace; Public
102193	637	2	16%	84%	Schedule 83	Public
100037	11,679	2	15%	85%	Schedule 83	Fleet; Workplace; Public
100035	11,545	2	12%	88%	Schedule 83	Fleet; Workplace; Public
102191	123	1	9%	91%	Schedule 83	Public
102194	10	1	0%	100%	Schedule 83	Public
102192	-	1			Schedule 83	Public
100039	1,107	4	59%	41%	Schedule 85	Public
100044	6,285	6	28%	72%	Schedule 85	Workplace
100024	83,154	13	11%	89%	Schedule 85	Fleet; Workplace; Public
100031	6,702	2	4%	96%	Schedule 85	Fleet; Workplace; Public
102773	9	1	NA	NA	Schedule 32	Public
100649	235	1	NA	NA	Schedule 32	Multifamily
102195	422	1	NA	NA	Schedule 32	Multifamily
100028	19,977	2	NA	NA	Schedule 32	Public
100029	7,580	2	NA	NA	Schedule 32	Public
100032	7,203	2	NA	NA	Schedule 32	Multifamily
100033	2,080	2	NA	NA	Schedule 32	Fleet, Workplace, Public
100040	291	2	NA	NA	Schedule 32	Workplace, Public
100041	1,541	2	NA	NA	Schedule 32	Workplace, Public
100026	11,954	6	NA	NA	Schedule 32	Fleet, Workplace, Public

Note: Peak time periods, as defined by Schedule 85 – Time of Use Rate, are from 6:00am – 10:00pm Monday through Saturday.

Table 46 presents the utilization summaries of the Business Charging Rebates Pilot sites. Utilization rates are calculated between a charger's first recorded session and their last recorded session, which are listed in Table 44.

Table 46. Business Charging Rebates Pilot Port Utilization per Site

Site	Use	Number of sessions	Charge utilization (through the latest session)	Plug utilization (through the latest session)
100037	Fleet, Workplace, Public	2	6.4%	7.8%
100039	Public	5	2.1%	3.5%
100026	Fleet, Workplace, Public	6	4.5%	11.1%
100024	Fleet, Workplace, Public	14	6.8%	11.6%
100032	Multifamily	2	1.9%	6.0%
100031	Fleet, Workplace, Public	2	4.6%	6.6%
100034	Fleet, Workplace, Public	2	15.1%	17.0%
100035	Fleet, Workplace, Public	2	7.1%	8.9%
100038	Fleet, Multifamily, Workplace, Public	18	7.5%	15.9%
100036	Fleet, Workplace, Public	2	2.8%	3.3%
100028	Public	2	12.5%	16.1%
100029	Public	2	4.1%	5.0%
100027	Fleet, Workplace, Public	1	3.4%	4.6%
100025	Workplace	2	7.3%	12.9%
100033	Fleet, Workplace, Public	2	1.2%	1.3%
100043	Fleet, Workplace, Public	4	14.0%	16.5%
100040	Workplace, Public	2	1.6%	7.4%
100041	Workplace, Public	2	5.3%	7.0%
100044	Workplace	7	5.8%	8.0%
102189	Public	2	1.8%	2.4%
102194	Public	1	0.3%	0.5%
102191	Public	1	5.9%	6.2%
103052	Multifamily	4	4.1%	4.4%
100648	Public	3	1.2%	1.3%
100645	Public	4	7.0%	7.8%
102773	Public	1	1.3%	1.4%
102193	Public	2	4.7%	4.9%
102192	Public	1	1.6%	1.6%
102197	Public	2	0.6%	0.8%
102195	Multifamily	1	3.0%	3.2%
100010	Fleet	4	33.2%	41.6%
100649	Multifamily	1	5.2%	9.7%

APPENDIX C. FLEET PARTNER PILOT: IMPACT ANALYSIS METHODS AND CHARGING PATTERNS

APPENDIX C-I. DATA CLEANING AND PREPARATION

Time Series Verification

The evaluation team verified the time series construction conducted by PGE. We identified a no misalignment between the session and constructed time series data.

Session Data

The evaluation team relied on the comprehensive data extract provided by PGE for session data. Since the same file was used for time series reconstruction, which led to the duplication of sessions, we filtered the data to only session-level information and removed any duplicates to apply cleaning steps to the session data. As part of the session data cleaning, we reviewed the data for duplicate records, addressed gaps and conflicting information (where possible and reasonable), and subset the data to the relevant reporting period (pilot start through August 2023).

Table 47 summarizes cleaning steps made to the session data set as part of the data preparation and cleaning process. The cleaned session data is then used to update the time series data.

Table 47. Fleet Partner Pilot Session Data Cleaning Steps

Step	Type	Update/Drop	Remaining Unique Session IDs	Percent Remaining
Initial Count	NA	NA	285	100%
Invalid plug start and end times	Drop	0	285	100%
Missing Charge Start/End Times	Drop	0	285	100%
Invalid Charge start and end times	Drop	0	285	100%
Updating plug start times to align with charging start times	Update	44	285	100%
Updating plug end times to align with charging end times	Update	0	285	100%
Sessions with 0 seconds between plug start and end	Drop	0	285	100%
Sessions with 0 seconds between charging start and end	Drop	1	284	99.6%
Sessions with 0 consumption	Drop	3	281	98.5%
Subset data to the relevant time period	Drop	36	245	86.0%

Time Series Data

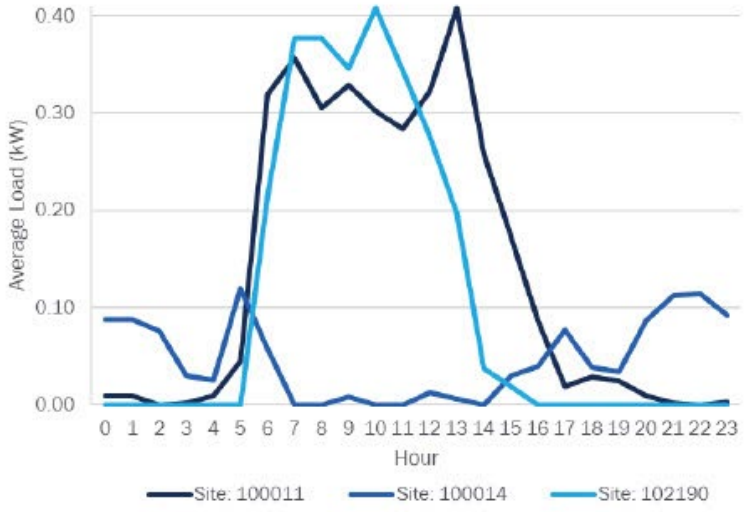
The cleaned session data was used to update the time series data. Sessions that were dropped in session data cleaning were also eliminated from the time series data and any updated session information was applied to the time series data. Exact duplicates were also dropped. No cleaning was conducted on the charging start and end dates, so reconstruction of the data was not required. Once the time series data was updated, it was then aggregated to an hourly level, missing records were imputed, and the data was subset to the relevant reporting period. Days missing 24 hours of interval data were removed from the analysis.

APPENDIX C-II. CHARGING PATTERN ANALYSIS

Figure 56 and Figure 57 present additional average hourly electricity consumption load curves by day type and site.

Figure 56. Fleet Partner Pilot Average Load Curves per Day Type

Figure 57. Fleet Partner Pilot Average Load Curves per Site



APPENDIX D. FLEET PARTNER PILOT: INTERIM FINDINGS

APPENDIX D-I. INTRODUCTION

This memorandum summarizes the findings from in-depth interviews that Opinion Dynamics conducted with fleet managers who have either permanently or temporarily disengaged with Portland General Electric's (PGE) Fleet Partner Pilot, as well as interviews with pilot staff. Additionally, this memo presents findings from secondary research conducted on current fleet electrification programs offered by peer-utilities, including documenting program requirements and incentive levels.

PGE's Fleet Partner Pilot aims to reduce costs and complexities for managers of nonresidential fleets who are interested in transitioning to electric fuel and create a network of demand response (DR) enabled electric vehicle (EV) charging that can support efficient grid operations and future renewables integration. There are two components of the Fleet Partner pilot:

- **Fleet Partner Plan:** Includes EV feasibility assessments, vehicle operations and charging analyses, fuel cost and clean fuel credit analyses, site walkthroughs, design and cost estimates, and an incentive summary delivered in a comprehensive Fleet Partner Study.
- **Fleet Partner Build:** Customers who complete a Fleet Partner Study can join the reservation list for the Build phase, which includes turnkey final design, construction of make-ready infrastructure, incentives, and PGE ownership of make-ready.

Opinion Dynamics conducted interviews with pilot staff, inactive fleet managers, and secondary research to provide PGE with early feedback on reasons for pilot attrition and non-participation in the Fleet Partner Pilot, which PGE can use to adjust the pilot design if needed. In addition to the evaluation activities covered in this memo, we will conduct interviews with pilot participants who completed the Build phase of the pilot, field surveys with participants who completed a Fleet Partner Study, and conduct an analysis of installed charging load data, pending data availability. We will present findings from these additional evaluation activities in the 2023 Annual Report.

APPENDIX D-II. RESEARCH METHODS

APPENDIX D-II.I. IN-DEPTH INTERVIEWS

Between April and May of 2023, Opinion Dynamics conducted in-depth interviews with eight Fleet Partner Pilot staff, including the product manager, key customer managers (KCMs), engineering, marketing, and business outreach staff. The interview objectives were to better understand PGE's progress towards meeting the participation goals set for the Fleet Partner Pilot, highlighting the successes and challenges of the pilot since its launch.

In May of 2023, the research team conducted in-depth interviews with four of five fleet managers who inquired about the Fleet Partner Pilot, applied, but withdrew their application. The interviews included questions about pilot marketing efforts, reasons for withdrawing from the pilot, participation challenges that PGE could address, the appropriateness of the custom incentive for make-ready infrastructure, and the usefulness of the online Total Cost of Ownership (TCO) planning tool. The team recruited interviewees via email from a PGE-provided list of five contacts who withdrew from the pilot. All interviewees were offered a $100 incentive for completing the interview.

Inactive fleet managers reported managing fleets in PGE's service area of various sizes, which they utilize for a variety of commercial purposes (Table 48). Three of the four interviewees manage only light- or medium-duty commercial

vehicles while the remaining interviewee manage heavy-duty industrial vehicles. Two interviewees had existing EVs as part of their fleets, while the others had only gas or diesel vehicles.

Table 48. Inactive Fleet Manager Interviewee Characteristics

Property Type	Type of Organization	Type of Fleet Vehicles	Current EVs	Approximate Fleet Size
Commercial	Transit Bus Contractor	School buses & motorcoaches	0	845
Commercial	Electrical Contractor	Transit vans	0	355
Municipal	Recreation & Park District	Passenger & industrial vehicles	4 EVs, 3 PHEVs	100
Commercial	Auto Dealership	Passenger vehicles	8 EVs	8[b]

[a] This interviewee mentioned that they already have eight EVs and wanted to know if the pilot could provide incentives for upgrading their existing charging.

APPENDIX D-II.II. OPTIMAL INCENTIVE LEVEL RESEARCH

In addition to asking inactive fleet managers for their opinion on current Fleet Partner make-ready incentive levels, Opinion Dynamics conducted a review of other utility fleet electrification programs in the United States to document incentive levels offered by other utilities. We reviewed 13 utility programs, documenting program requirements, incentive types, and incentive levels.

APPENDIX D-III. KEY FINDINGS AND RECOMMENDATIONS

This section summarizes the overarching findings from interviews with pilot staff and inactive fleet managers and secondary research on peer-utility fleet electrification programs.

- Key Finding #1: Pilot staff mentioned two key challenges that the pilot is currently facing: a shortfall in available funding and supply chain issues. As of January 2023, funding for make-ready build-out was exhausted, leading to some customer frustration. Pilot staff hope to receive additional funding as part of the new Transportation Electrification Plan but expect to make changes to make-ready incentive levels. Additionally, staff mentioned challenges with extended delays in procuring equipment, including transformers and switchgear, leading to elongated project timelines.
- Key Finding #2: Current make-ready incentive levels likely could be decreased given the high demand for the pilot. Pilot staff reported that funding for the Build phase of the pilot was quickly exhausted and that with the current backlog of potential participants, the next round of funding will be exhausted with little additional marketing and outreach. Further, interviewed fleet managers reported that the amount of incentive offered through the pilot was not a contributing factor in their decision to withdraw their participation. Secondary research conducted by the research team suggests that current incentive levels align with other utility program offerings, however, making direct comparisons is challenging due to the variety of program and incentive configurations of fleet electrification utility programs.
    - Recommendation: Consider decreasing current make-ready incentive levels to allow for greater participation in the pilot. Additional research conducted with Plan and Build phase participants in 2023 can be leveraged to provide additional insights into optimal incentive levels.
- Key Finding #3: PGE KCMs and business outreach staff are currently key to generating leads for the Fleet Partner Pilot. Nearly all projects supported by the Fleet Partner Pilot were initiated by PGE staff, with few customers reaching out directly to PGE to inquire about electrification offerings. However, KCMs and business outreach staff mentioned challenges with staying up to date on current offerings and suggested better

coordination between KCMs and pilot staff so KCMs can better assist with the application and enrollment process. Direct outreach activities to customers include presentations and social media outreach (i.e., LinkedIn).

  - Recommendation 1: Consider providing regular updates to KCMs and business outreach staff about current transportation electrification offerings and updates on program requirements and incentive levels. Because KCMs and business outreach staff have established relationships with customers, consider closer coordination during the participation process, including involving staff in project kickoff meetings and providing project status email updates.
  - Recommendation 2: If additional funding becomes available, PGE could consider exploring alternative ways of engaging with fleets in its service territory.

- Key Finding #4: Meeting the 70 kW energy-use commitment is a key barrier mentioned by interviewed fleet managers and pilot staff. Some fleet managers reported that based on their current fleet vehicle utilization data, they would be unable to meet the energy consumption requirement within the timeframe specified by the pilot and withdrew their application.
  - Recommendation: After customers with large fleets are served, PGE may want to consider altering the Fleet Partner Pilot participation requirements to allow for increased participation of customers with smaller fleets. If smaller fleets are allowed to participate, consider adjusting incentive levels to support cost effectiveness for smaller charging loads.

APPENDIX D-IV. DETAILED INTERVIEW FINDINGS

- This section summarizes the findings from interviews with pilot staff and inactive fleet managers.

APPENDIX D-IV.I. PILOT CHALLENGES

Funding for make-ready build-out was exhausted in early 2023, leading to customer frustration. Many eligible participants on the reservation list for the Build phase are waiting for funds to come available to proceed. Pilot staff have found it challenging to communicate the funding issue to customers on the reservation list because of the risk of discouraging committed and eligible customers from continuing their participation. Moreover, when funding is available incentive levels will be reduced, which may cause customers to reconsider moving forward with the Build phase.

Supply chain issues associated with charging infrastructure equipment have increased project timelines and costs. Procuring charging infrastructure equipment has been difficult for the past couple of years due to global supply chain issues. Staff have seen delays in deliveries of transformers of up to 56 weeks and switchgears of up to 65 weeks. These long delays contributed to discrepancies between the estimated and actual costs for a handful of projects during the first Fleet Partner Pilot's infancy. One interviewed fleet manager mentioned that this is essentially a manufacturing problem that the pilot cannot alleviate. Still, staff mentioned that ordering equipment months ahead of the expected delivery date has helped with equipment deliveries and capital planning.

APPENDIX D-IV.II. AWARENESS OF FLEET ELECTRIFICATION AND PARTICIPATION BENEFITS

KCMs and business outreach staff play a key role in promoting the Fleet Partner Pilot by sharing information with their customers who have fleets. Customers have established relationships with KCMs and business outreach staff, and tend to consult them first to learn about PGE's offerings. Two of the interviewed fleet managers learned about the Fleet Partner Pilot from PGE staff. Another fleet manager reached out to PGE because one of their clients wanted to form a

partnership with them, PGE, and the school district to install make-ready infrastructure for electric school buses. The other fleet manager learned about the pilot from other municipalities.

Email outreach has been effective at raising awareness for fleet electrification and participation benefits among eligible customers. The product team's Salesforce dashboard, which tracks outbound communications, has been vital to this approach. Additional ways customers could have learned about the pilot include online searches for fleet electrification that lead to the PGE website, annual business review presentations, LinkedIn postings, and tabling at the 2022 Green Transportation Summit and Expo.

- KCM and business outreach staff need help to stay current on PGE transportation electrification offerings and want to be more involved during the participation process to support their customers. KCMs and business outreach staff would like more information about PGE's transportation electrification offerings. They would also like to be more involved during the Fleet Partner Pilot participation process, including attending their customers' project kickoff meetings. KCMs and business outreach staff suggested that pilot staff include them in project meetings and provide regular updates about changes to the pilot, so they can provide customers with accurate information and communicate customer needs.

APPENDIX D-IV.III. CHALLENGES TO FLEET ELECTRIFICATION AND PILOT PARTICIPATION

- The pilot's energy-use commitments are preventing some organizations from participating in the Fleet Partner Pilot. A requirement to participate in the Fleet Partner Pilot is to add a minimum of 70 kW of new load (usually equivalent to 10 Level 2 ports or 1-2 DC fast chargers) at the customer site. Two interviewed fleet managers were ineligible for the pilot due to the energy-use commitment. One interviewee elaborated, saying that after doing their own calculations using their fleet maintenance provider's vehicle management portal and EV fleet vehicle manufacturer data, they found that they could not meet the minimum 70 kW load requirement.

> "When we first, initially, were talking with them, we're kind of like, "Oh, yeah, maybe we could do a couple of vehicles, a couple SUVs, and then a couple of trucks... We went from thinking about 50 miles a day as the base, but we found out it was more like 15."

The other interviewee was hesitant to agree to the energy-use commitment because their company (a car dealership) was unlikely to use more EVs and/or chargers in the future. The customer was able to procure project funding via federal tax credits, which was a better fit for their needs.

> "I felt like I was stepping into a grey area because the pilot is not designed for car dealers... the intention of the pilot was to electrify a limo company or a bus company or a garbage hauling company. I understood what the intention of the pilot was as I got into it more, but I was looking for help."

- Changes in staffing at customer organizations during the participation process have been an ongoing challenge for fleet electrification and participation. Staff turnover at potential participant organizations can lead to missing funding opportunities. For example, a large organization that enrolled in the pilot replaced all project leads, and when the time came for the organization to sign and submit their application for funding, new staff were not familiar with the project. Pilot staff also find that it becomes increasingly difficult to get project approval when an organization adds more staff to the internal approval process.
- The initial staffing arrangement for Design Project Managers (DPMs) hindered fleet electrification and participation. The DPM team oversees utility infrastructure plans for every project in the Fleet Partner Pilot during the Plan phase. There was only one DPM available last year to work with contractors on final project designs. While the sole DPM performed high-quality work, they were overcapacity given the influx of fleet projects prompting pilot staff to bring in regional DPMs. The addition of regional DPMs has led to reduced project delays.

- For some organizations, the lack of a central charging location for their remotely located fleet vehicles is a major barrier to fleet electrification and participation. While it is not a common issue, there are some organizations that struggle to provide charging assistance to employees who take their fleet vehicles home. To overcome this challenge, some organizations plan to build centralized charging depots for employees to charge fleet vehicles.
- Having greater flexibility in choosing qualified contractors could increase participation. One interviewed fleet manager who worked for an electrical contracting company withdrew from the pilot because they could not come to an agreement with PGE on completing the Build phase themselves, rather than choosing a direct competitor from the list of pilot-approved contractors. They mentioned that they would have continued with the pilot if PGE had not denied their request to install the purchased equipment themselves.

> "It's perception more than anything... The approved contractors were our direct competition. I think the experience, up to the point we couldn't agree on terms, was fine... if we weren't an electrical contractor, it would probably already be in process. We'd probably be installing.".

Satisfying grid interconnection agreements and feasibility testing can be a challenge for some projects. One interviewed fleet manager mentioned that a distributed energy project that they launched while also working with the pilot was temporarily put on hold when an important customer contract for establishing grid interconnections was lost. While the fleet manager said that this issue was later resolved by regaining the contract, they also mentioned feasibility testing for the vehicle-to-building (V2B) and vehicle-to-grid (V2G) switchgear technology was time-consuming and delayed due to supply chain constraints.

APPENDIX D-IV.IV. CURRENT MAKE-READY REBATE LEVELS

Current incentive levels were sufficient and not a reason why interviewed fleet managers withdrew from the pilot. All interviewed fleet managers reported that that they withdrew from the pilot for reasons unrelated to incentives. Of the four interviewees, two said that their withdrawal from the pilot was due to the 70 kW energy-use commitment requirements discussed above. The fleet managers reiterated that their fleets' actual mileage use was too low to meet the pilot requirement.

APPENDIX D-IV.V. FUTURE FLEET ELECTRIFICATION PLANS

Three of the four fleet managers indicated that they have no further fleet electrification plans. The customer who still has electrification plans manages the largest fleet among the interviewees and stated that they are striving to be a leader in fleet electrification within their industry. The company is doing work to set up the make-ready infrastructure needed to support future electrified fleet vehicles that they will be procuring slowly over many years. This customer mentioned a new project with the Fleet Partner Pilot, and that they are currently working with PGE staff and partners to conduct a feasibility test for specific equipment to establish the interconnection agreement required to proceed to the Build phase.

APPENDIX D-V. REVIEW OF PEER-UTILITY FLEET PROGRAMS

Opinion Dynamics reviewed the program designs and incentive levels for 13 different fleet electrification programs offered by utilities across the United States. Utility fleet electrification programs come in several different configurations based on the energy goals and financial needs of the businesses that the electric utilities serve. As a result, utilities offer a variety of incentives for EV make-ready infrastructure, EV supply equipment (EVSE) procurement, and electric fleet vehicles.

A key objective of this research was to identify typical incentive levels for fleet programs. Given the varied program designs and incentive levels, we were unable to identify a typical incentive level. Below, we summarize the key program design elements and range of incentives for current fleet electrification offerings. In addition, Table 49 provides a summary of the 13 programs reviewed allowing for a comparison of these programs with the Fleet Partner Pilot's participation requirements and incentive levels.

- Similar to PGE's Fleet Partner Pilot, all utility programs reviewed provided fleet electrification assessments.
- Eight out of thirteen fleet electrification programs offer incentives for both make-ready infrastructure and EVSE projects, with four offering additional incentives for electric fleet vehicle procurement. Additionally, one program provided grant-finding and writing support for EVSE projects.
- Maximum incentive levels for make-ready infrastructure projects varied based on customer charging needs, the type of community that the proposed project would serve, and the type of fleet vehicles that would use the charging infrastructure. Eligible customers enrolled in these programs may receive incentives covering anywhere between 50% to 100% of the upfront costs for make-ready projects.
- EVSE incentive levels varied by utility, ranging from $500 to $4,500 per serviced Level 1 or Level 2 charger and $7,500 to $30,000 for DC fast chargers.
- Individual program requirements varied by utility. For example, ten programs required that customers are responsible for annual maintenance costs while the remaining three required that the customers agree to transfer that responsibility to the utility, which is typically associated with no-cost installation of the make-ready infrastructure.

Table 49. Summary of Utility Fleet Program Offerings

Program Name	Utility	Program Offerings				Program Requirements	Program Incentive Levels
		Assess-sment	Make-Ready	Chargers	EVs		
Fleet Partner Pilot (Phase 1)	Portland General Electric	✓	✓	-	-	Charging site(s) must be in PGE service area and customers are responsible for charger costs, annual maintenance costs, electricity costs, and any make-ready costs not covered by the custom cost incentive. Customers must meet make-ready design of at least 70 kW of connected load (usually equivalent to 10 Level 2 ports or 1-2 DC fast chargers) and share charging data with PGE for 10 years, commit to forecasted energy use of the chargers and sign an easement covering PGE-owned infrastructure as well as agree to terms of Participation Agreement.	**Make-ready:** Up to $750,000 or the make-ready costs per customer, whichever is less. The higher the energy use commitment, the higher the incentive could be.
PowerMIFleet Pilot	Consumers Energy	✓	✓	✓		Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs. Must add at least one EV to fleet while still participating in program, within 6 months of notifying utility of rebate selected. Customer must have existing make-ready infrastructure on the property to take advantage make-ready rebates.	**Make-ready:** Rebates to reduce costs of upgrading existing make-ready infrastructure if customer agrees to install chargers. **Chargers:** Up to $5,000 per L2 (limit 10 per site), $35,000 per non-public DCFC, and $70,000 per public-use DCFC.
eFleet Charger Rebate Program	DTE Energy	✓	-	✓		Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs for at least 5 years after the installation date.	**Chargers:** Up to $2,500 for L2 and up to $70,000 for DC fast chargers. Rebate amounts capped to DTE Energy's discretion at a maximum level per site and per participant if installing L2 or DCFC EVSE.
Electric Transportation Make Ready Program	Georgia Power	✓	✓	✓		Customers agree to have make-ready infrastructure installed, owned, and operated by utility. Chargers must be in an area that property owners agree the general public may access. Restricted access chargers	**Make-ready:** Capped at $200,000 per project. A Contribution in Aid of Construction (CIAC) charge is imposed on the requesting customer for anything over the cap to cover any differences. **Chargers:** Up to $500 for

Program Name	Utility	Program Offerings				Program Requirements	Program Incentive Levels
		Assessment	Make-Ready	Chargers	EVs		
						are not eligible for Make Ready program infrastructure funding. Privately owned fleets are not eligible. Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs. The program requires a minimum of six chargers(ports) for a Level 2 charger or at least one DC fast charger. Anything less will be eligible for the charger rebate program.	each L2 charger (Max total of $2,500 per account).
EV Make-Ready Program	Joint Utilities of New York	✓	✓	✓		Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs.	**Make-ready and Chargers:** 3-tiered Incentive up to 100% cost reduction of make-ready largely based on type of community, number of ports, and charger type. Incentive cap depends on the utility, but all caps are under $6,000 for L2 and $8,000 for DCFC chargers.
Fleet Advisory Services and Charging Program	National Grid USA	✓	✓			Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs.	**Make-ready:** 3-tiered incentive up to 100% of make-ready funding for eligible light-duty fleets and up to 90% of utility-side make-ready costs for medium and heavy-duty fleets.
EV Fleet Program	Pacific Gas and Electric (PG&E)	✓	✓	✓		Customers must provide property easement and acquire at least 2 medium- or heavy-duty EVs by 2024. Customers provide EV utilization data for at least 5 years after charger activation and operate/maintain chargers of min 50 kW charging capacity for at least 10 years.	**Make-ready:** Up to $9,000 in funding for to-the-meter (TTM) and make-ready costs per eligible vehicle purchased, capped at 25 vehicles. **Chargers:** Up to 50% of cost up to $42,000 towards charger costs.
Charge at Work Rebates for Businesses	Pacific Power (Oregon)	✓		✓		Customers agree to time of use enrollment if small non-residential customer (a consumer whose demand has not exceeded 30 KW or more) and commit to participation for 13 months. Customers	**Chargers:** Up to $1,000 awarded per port towards charger costs, not to exceed 75% of total costs. Max incentive is $6,000 (total 6 ports). Also offers grant-finding and writing support, and

Program Name	Utility	Program Offerings				Program Requirements	Program Incentive Levels
		Asses-sment	Make-Ready	Chargers	EVs		
						purchase and install qualified EV chargers (some chargers also require software to qualify), but installations must be hardwired for permanency. Customers must also submit a rebate application within one year of the date of purchase.	technical assessment or assistance with projects. Charger incentive cap is set at 75% of the total project costs, which can include charger, permit, or electrical work costs.
PSE Up & Go Electric for Fleet	Puget Sound Energy (PSE)	✓	✓	✓	✓	Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs for at least 10 years and must procure at least two owned or leased EVs (or one if qualified Empower Mobility customer) for fleet by the EVSE installation and activation date.	**Make-ready and Chargers:** Multi-tiered Incentive up to $4,000 awarded per L2 port and up to $60,000 per DCFC port owned by customer, or up to $10,000 per L2 and up to $125,000 per DC fast charger owned by utility. Incentive capped at $250,000 per charging location. **Fleet vehicles:** Offers additional technical advisory services and enhanced incentives on both electric vehicle service equipment and electric vehicles to community-based organizations, Tribal entities, government agencies and BIPOC-owned small (Up to $2K per EV) businesses. Load management incentives are also offered.
Charge Ready Transport Program	Southern California Edison (SCE)	✓		✓		Customer must lease, purchase, or convert at least two medium- or heavy-duty battery-powered EVs, own or lease the property where chargers are installed, Make-ready incentive based on forecasted energy use of the chargers, up to $750,000 operate, and maintain chargers for a minimum of 10 years that are utility-approved, provide data related to charging equipment usage for at least 5 years (on-road vehicles only). All charging equipment will be	**Chargers:** Many customers, including transit agencies and businesses in disadvantaged communities that are not on the Fortune 1,000 list may qualify for an equipment rebate up to 50%.

Program Name	Utility	Program Offerings				Program Requirements	Program Incentive Levels
		Assessment	Make-Ready	Chargers	EVs		
						required to take service on a time-of-use rate plan.	
Power Your Drive for Fleets	San Diego Gas & Electric Company (SDG&E)	✓	✓	✓		Only applicable to Class 2-8, on-road and off-road fleet customers. Customer must provide data related to charger usage for a minimum of 5 years and operate and maintain vehicles and chargers for a minimum of 10 years. Chargers must meet a minimum of 19.2 kW charging capacity.	**Make-ready:** Two options (1) No cost installation and maintenance of utility side infrastructure. (2) Customer pays for, constructs, owns, and maintains all infrastructure up to the meter or "customer-side infrastructure" and charging stations and utility provides a rebate of up to 80% towards the costs. Per charger incentive caps are based on EVSE capacity ($3K for up to 19.2 kW, $15K for 19.3 kW to 50 kW, $45K for 50.1 kW to 150 kW, and $75K for over 150 kW). Rebate for each qualified charger not exceeding 50% of the cost. **Chargers:** Additional charger rebates up to $75,000 per charger or up to 50% of total charger costs for eligible customers in disadvantaged communities, whichever is lesser.
Fleet Electrification Program	Seattle City Light (SCL)	✓	✓	✓		Customers agree to behind-the-meter and to-the-meter utility-ownership terms for make-ready infrastructure. Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs. Chargers must meet a minimum of 19.2 kW charging capacity.	**Make-ready and Chargers:** Up to 50% of total charger and make-ready infrastructure installation costs awarded to eligible customers in non-environmental justice community and additional financial assistance to fleets within environmental justice communities (up to 100% in total). Up to $4,000 and $50,000 provided per L2 and DC fast charger, respectively, for on-road electric equipment and up to $4,000 and $100,000 provided per L2 and DC fast charger, respectively,

Program Name	Utility	Program Offerings				Program Requirements	Program Incentive Levels
		Asses-sment	Make-Ready	Chargers	EVs		
							for non-road electric equipment. Make-ready incentives are subject to a cap of $200,000 per site and per customer or 50% of total charger and installation costs or the per-port incentive cap, whichever is lower. Additional funding caps per site may apply.
Commercial EV Program	SMUD (Sacramento Municipal Utility District)	✓	✓	✓	✓	Customers must be the utility customers of record at the location where the EVSE is located, must demonstrate adequate assurances of both physical and contractual permanence prior to receiving an incentive. Applicant will have 30 calendar days from date of inspection failure to bring the Project into compliance, or the Project will be dropped from the incentive program with option to reapply once the deficiencies are addressed.	**Make-ready and Chargers:** $500 to $4,500 per serviced EVSE (L1 or L2) and $7,500 to $30,000 for public-facing DC fast charger installation; $5,000 per transformer upgrade, $1,000 per panel upgrade support for new EVSE load, and $250 per stub out (infrastructure maintenance). Incentives cannot exceed 100% of project costs. **Fleet vehicles:** Rebate from $750 to $15,000 for EV costs.
EV Charging for My Fleet	Xcel Energy Colorado	✓		✓		Be a non-profit or public organization eligible to participate in Xcel Energy's non-profit efficiency programs or located in a Higher Emissions Community.	**Chargers:** Rebates up to $2,200 for L2 and Up to $45,000 for DC fast chargers, and up to $275,000 for electric school bus Projects

Opinion Dynamics

CONTACT:

Zac Hathaway
Principal Consultant
zhathaway@opiniondynamics.com

BOSTON
PORTLAND
SAN DIEGO
SAN FRANCISCO

All product or company names that may be mentioned in this publication are tradenames, trademarks or registered trademarks of their respective owners.

PGE

PGE Clean Fuels Program 2023 Annual Report

1- PGE 2023 Oregon CFP Report

Table of Contents

Introduction

Portland General Electric Company (PGE, or the Company) is pleased to submit its 2023 Clean Fuels Program (CFP) report to the Oregon Department of Environmental Quality (DEQ) as required by OAR 340-253-0640(11). This report covers PGE's programs and expenditures for the 2023 calendar year for its activities funded by the sale of Clean Fuels Program credits generated through residential electric vehicle (EV) charging in PGE's service area.[1]

PGE plans CFP-funded programs through an iterative approach with stakeholders in consultation with DEQ and the Oregon Public Utility Commission (OPUC) staff. This iterative approach is facilitated by OPUC staff as part of Order No. 18-376 in Docket No. UM 1826 and Order No. 22-314 in docket No. UM 2165. These orders established five program design principles that investor-owned utilities must follow when planning CFP-funded programs as shown in figure 1.

Figure 1. OPUC Clean Fuels Program Design Principles

As part of part of Order No. 22-314, starting with the 2023 CFP program year the program planning process is now part of investor owned utilities' Transportation Electrification (TE) Plans.[2] Since PGE's draft TE plan was not scheduled to be filed until June 2023, PGE filed the 2023 CFP plan separately in February of 2023. Plans for 2024-2025 were included in PGE's 2023-2025 TE Plan, which was accepted by the OPUC on October 20, 2023.

Starting in 2020, PGE proposed a portfolio approach to residential clean fuels funded programs. PGE consulted with stakeholders to consider what types of programs to support through a portfolio approach. Based on stakeholder input, market research, and CFP participation, PGE developed a portfolio method to plan for the CFP going forward. These programs are organized in the following categories:

Grants and Infrastructure to accelerate equitable deployment of vehicles and charging across Oregon;

Education and Outreach to increase awareness of transportation electrification, dispel existing misconceptions, and help create an ecosystem of support roles (e.g., EV/Charger maintenance job training, re-training) that promote a dependable customer experience; and

[1] This report encompasses actives funded through PGE's participation in the Oregon Clean Fuels program not ratepayer funded transportation electrification activities.
[2] On August 26, 2022 the OPUC adopted Order No. 22-314, which amended Order No. 18-376 to eliminate CFP Design Principle of "Programs are designed to be independent from ratepayer support" revised the process for stakeholder review and input into PGE's CFP-funded activities within the TE Plan process.

Emerging Technology to test new concepts that have an EV nexus and the ability to scale to larger utility programs.

Additionally, administrative costs are tracked and expected to remain below ten percent of total annual expenditures. While funding amounts vary from year to year based on residential CFP revenue, PGE plans for the approximate budget breakdown and percentages below for the Clean Fuels portfolio submissions:

Table 1-CFP Program Percentage Targets

Category	% Portfolio per Year
Grants and Infrastructure	70% - 80%
Education and Outreach	5% - 15%
Emerging Technology	5% - 15%
Administrative Costs	5% - 10%

PGE's 2023 Clean Fuels Program Plan was presented to stakeholders and the OPUC[3] in March 2023 as follows:

Table 2-2023 Clean Fuels Program Plan

Program Category	Total Cost	Portfolio Estimate %
Grants and Infrastructure	$9,054,000	77%
Education and Outreach	$1,176,000	10%
Emerging Technology	$588,000	5%
Administrative Costs	$941,000	8%
PORTFOLIO TOTAL	**$11,758,800**	-

Total Revenue from the Sale of Base and Incremental Credits

PGE's 2023 programs were funded through the sale of credits in 2022 generated from residential EV charging in 2021. DEQ's 2021 CFP rulemaking introduced the concept of base and incremental credits. Base credits are generated through use of a fuel with carbon intensity (CI) lower than that of gasoline or diesel. Incremental credits are generated when a registered entity claims a lower carbon intensity of electricity by retiring RECs alongside claiming CFP credits for EV charging. PGE did claim incremental credits in 2022 for residential CFP 2023 programs: the DEQ assigned 46,752 incremental credits to PGE, resulting in approximately

---

3 https://apps.puc.state.or.us/edockets/edocs.asp?FileType=HAH&FileName=um2033hah162744.pdf&DocketID=22127&numSequence=53

4- PGE 2023 Oregon CFP Report

$5,394,400 in incremental revenue. [4] In 2023 PGE purchased RECs to claim incremental credits for 2022 to fund 2024 programs. In addition, PGE purchased $763,576.65 of RECs which resulted in approximately $8,825,609 in incremental credit revenue to be utilized for the 2024 program year.

PGE began 2023 with 22,306 credits in its account. On March 24, 2023, the DEQ deposited 29,298 base residential credits and on May 5, 2023, DEQ deposited 65,976 residential incremental credits into PGE's account in the CFP system. On October 31, 2023, DEQ deposited 43,844 residential base credits for the EV count for the first six months of 2023. PGE ended the year with 39,522 credits in the account. Between January 1, 2023, and December 31, 2023 PGE executed 15 separate sales of CFP credits at an average price of $133.77 per credit, with proceeds of residential credits totaling $17,832,993. The 2023 residential credit revenue from 2022 residential EVs will fund 2024 CFP Programs.

2023 Residential Clean Fuels Program Expenditures

Following the portfolio approach PGE's 2023 CFP expenditures break down as follows:

Table 3- 2023 Clean Fuels Program Expenditures

Program Category	Amount spent by close of 2023	Percentage of Overall Expenditure
Grants and Infrastructure	$6,847,600	82%
Education and Outreach	$320,294	4%
Emerging Technology	$86,849	1%
Administrative costs	$378,150	5%
REC costs	$766,095	9%
Total	**$8,398,989**	**100%**

The vast majority of expenditures (82%) fell into the category of grants and infrastructure, which reflected both the Drive Change Fund (DCF) and the Electric School Bus (ESB) fund, as well as the public charging infrastructure upgrades. For both the DCF and ESB, 25% of the grant fund is retained until the projects are successfully closed. The next highest cost category was the procurement of RECs. Since this was a significant expenditure (9%) it is included as an individual line item. As outlined above, the purchase and retirement of these RECs facilitated an additional 65,976 incremental CFP credits for 2022 residential EVs, which will fund 2024 CFP programs (just as the 2022 REC purchases supported incremental credits revenue sales that supported the 2023 CFP programs). Education and Outreach represented four percent

[4] Note that there is a two-year delay between CFP credit generation and the programmatic year, so the 2023 program year was funded by incremental credits generated in 2021.

of CFP program expenditure, followed by CFP administrative costs at five percent and Emerging Technology at one percent.

In recognition that the Company underspent in Education and Outreach and Emerging Technology categories, PGE dedicated a program manager to these areas In October 2023, PGE expanded its capacity to drive these program initiatives forward by bringing on this new CFP resource. The company expects more activity expenditures in these areas in 2024. Additionally $1.5M of these unspent funds were redirected to increase the 2024 ESB fund and swiftly deploy these resources to the benefit of residential customers.

Program Descriptions

The following section provides further detail on PGE's CFP-funded programs

INFRASTRUCTURE AND GRANTS

Drive Change Fund

The Drive Change Fund is a competitive grant available to non-residential customers for transportation electrification projects that prioritize underserved communities, advance transportation electrification, and benefit residential customers.[5] Table 4 details eligibility, grant scopes which can be considered, and other elements of the program.

Table 4- Drive Change Fund Program Criteria

Applicant Eligibility	• Applicants may be nonprofit, for-profit or government entities, with a preference for nonprofit and government; • Applicants need not be PGE customers; however, projects must provide a community benefit in areas PGE serves.
Grant Scope	• Projects must advance TE and provide a benefit to residential customers, with priority given to projects that address the needs of underserved communities; • Applicants should demonstrate efforts to obtain all other available funding sources, incentives, federal grants, and tax credits; • Any charging stations that are funded must be part of the PGE qualified product list; • Where appropriate, PGE claims Clean Fuels credits to continue to fund the DCF.
Other Assistance	• Financial assistance is offered to compensate qualifying nonprofit applicants for staff time required to prepare an application; • Where possible, PGE may direct applicants to other complementary funding streams and synchronize application processes.

[5] In Oregon Communities underserved by Transportation Electrification are defined in HB 2165 as residents of rental or multifamily housing, communities of color, communities experiencing lower incomes, tribal communities, rural communities, frontier communities, coastal communities, other communities adversely harmed by environmental and health hazards, communities with a low density of public charging stations and the deployment of electric school and transit buses.

Process	• A third-party evaluator evaluates the applications, with an internal PGE selection committee making final funding decisions.

Since 2019, PGE has managed the DCF as described above and awarded over $12.59 million in grant funding to 74 projects. PGE ran the fifth cycle of DCF in 2023, awarding $3.67 million to 20 community transportation electrification projects. Table 5 provides a breakdown of the projects awarded and Appendix A details project summaries.

Table 5- 2023 Drive Change Awardees

Organization Name	Org Type	Project Type	# of EVs	# of Other Vehicles	# of Ports	Approx. Final Award Amount
Bird Alliance of Oregon (formerly Audubon Society of Portland)	Nonprofit	EVs, Chargers	3		6	$410,310
Catholic Community Services Foundation	Nonprofit	EVs, Chargers	1		2	$82,240
City of Salem Public Works Department	Government	EVs		1 compact street sweeper		$225,000
Columbia Slough Watershed Council	Nonprofit	EVs	1			$59,770
The Community Services Network	Nonprofit	EVs, Chargers	1		4	$144,590
Constructing Hope Pre-Apprenticeship Program	Nonprofit	EVs, Chargers	2		4	$218,170
Corbett SD 39	School District	EVs, Chargers	2		2	$216,450
Ethiopian and Eritrean Cultural Resource Center	Nonprofit	EVs	2			$156,750
Family Building Blocks	Nonprofit	EVs, Chargers	1		1	$296,390
Friends of Noise	Nonprofit	EVs, Chargers	1		2	$64,380
Friends of Trees	Nonprofit	EVs, Chargers	3		4	$245,980
Growing Gardens	Nonprofit	EVs, Chargers	3		6	$226,670
Habitat for Humanity Portland Region	Nonprofit	EVs, Chargers	1	4 forklifts	8	$204,900
Latino Network	Nonprofit	EVs, Chargers	1		8	$199,640
Northwest Pilot Project	Nonprofit	EVs	1			$83,400

Organization Name	Org Type	Project Type	# of EVs	# of Other Vehicles	# of Ports	Approx. Final Award Amount
OHSU	Nonprofit	EVs, Chargers	3		3	$262,490
SOLVE	Nonprofit	EVs, Chargers	1		2	$71,260
The Street Trust	Nonprofit	EVs		75 e-bikes		$266,725
United Way of Mid-Willamette Valley	Nonprofit	EVs		1 EV switch kit[6]		$65,000
Virginia Garcia Memorial Foundation	Nonprofit	EVs	1			$52,000
Totals			**28**	**81**	**52**	**$3,552,115**

Awardees receive 75% of the grant award at the beginning of the project and up-to the remaining 25% after projects are completed (based on actual project costs). Prior year awardees continued to implement and complete projects in 2023. A few notable milestones include the arrival of Oregon's first electric garbage truck (City of Roses Recycling), 25 ebikes (Portland State University), and an electric tractor (Working Theory Farm).

[6] An EV switch kit is a package designed to convert a gasoline-powered vehicle into an electric vehicle.

Image 2-Prior year (2020) DCF awardee Portland State University with two of the twenty five electric bikes they lend to students as a part of their bike hub program.

PGE continues to seek feedback from stakeholders, applicants, recipients, and transportation electrification organizations to strategies to fully achieve OPUC's program design principles, with the goal of creating an equitable application, evaluation process, and funding deployment structure. PGE updates and refines the DCF annually with an aim of improving the process for applicants, particularly for smaller community organizations. In 2023, PGE enlisted Opinion Dynamics to conduct an external evaluation of the grant. This evaluation focused on the 2021 cohort of DCF awardees who had competed or were nearing project completion. PGE has since implemented many of the recommended changes. The full evaluation can be found in Attachment B. Table 6 presents some of the changes PGE made in 2023 based on this feedback.

Table 6. Incorporation of Feedback and Program Enhancements in the Drive Change Fund

Outreach and Education

- Hosted a first-time awardee Connection and Celebration event to honor the impact of five years of the Drive Change Fund
  - Awardees from all five years attended, as well as PGE staff and key stakeholders, with breakout groups for discussion and knowledge sharing

Timeline

- Shortened the evalution period of the grant cycle to improve response timeline
- Initial award check cut in the year of award to reduce overall cycle time of grant, improve reporting, and improve budget tranparency

Program Management

- Full migration to a grants management platform (Cybergrants) to streamline the process for applicants, awardees, and admin
- Improved tracking for installed charging/ports

Program Improvements

- New third-party grant evaluator brought improvements to grant selection and evaluation processes
- Toolkits/media guides for DCF and ESB awardees - increased storytelling and awareness of TE
- Ensured alignment across applicant materials and award agreement terms
- Held two photo shoots to acquire media assets with DCF awardees

Electric School Bus Fund

The Electric School Bus Fund is a competitive grant available to public school districts located in PGE's service area to help fund the incremental costs of purchasing electric school buses, with a focus on school districts that serve underserved communities. Since 2020, PGE has awarded over $7.9 million in grant funding to school districts resulting in 30 electric school buses. In 2023, PGE allocated approximately $3 million to help school districts and school bus fleet operators acquire electric buses and charging infrastructure. PGE awarded grants to five districts to fund a total of eleven buses. These buses are in addition to the nineteen now operating or on-order from prior year grant awards. In 2023 PGE wrote a report on the findings from the first three years of the ESB fund.

Table 7- 2023 Electric School Bus Fund Awardees

School District	Project County	# of Buses	Total amount awarded for electric school bus and charging infrastructure[7]
Beaverton School District	Washington	1	$220,326
Molalla River School District	Clackamas	1	$391,344
North Marion School District	Marion	2	$632,688
Salem-Keizer Public School District	Marion/ Polk	1	$280,842
Tigard-Tualatin School District	Washington	2	$521,424
Portland Public Schools	Multnomah	2	$301,110
Willamina School District	Yamhill	2	$632,688
Total	-	**11**	**$2,980,422**

As of March 2024, all school districts awarded ESB funds in 2023 have placed their orders for electric school buses. The lead time for delivery of electric school buses ranges from 12-18 months, so most are not expected to be in service until late 2024 / early 2025. Three new school districts were first-time awardees in 2023: Molalla River, North Marion, and Willamina. For the 2023 award year, Molalla River, North Marion, Tigard-Tualatin, and Willamina School Districts all received funding for charging infrastructure. Beaverton, Salem-Keizer, and Portland School Districts did not receive additional funding for infrastructure from the 2023 ESB fund, as they had sufficient infrastructure from prior grant years or through participation in in PGE's Fleet partner Program.[8]

[7] Final total award amount varies based on actual infrastructure costs.
[8] More information on PGE's Fleet Partner program can be found here: https://portlandgeneral.com/energy-choices/electric-vehicles-charging/business-charging-fleets/fleet-partner

Image 3- A driver of one of Beaverton School District's electric school buses

Matching External Funds

In 2023, PGE reserved up to $543,000 to provide matching funds to public agencies, community-based organizations, nonprofits, educational institutions, and other partnerships applying for external funding. A total of six applications were submitted; three of which were approved for matching funds, with two having already received funding. Details on the two funded projects are included in the table below. The third was not awarded the external grant and therefore matching funds were not issued. The remaining funding will be put toward the 2024 DCF and ESB totals.

Table 8 – Successful Awarded 2023 Matching External Funds

Organization Name	External Grant Source	Amount Requested from PGE	Brief Description
Portland Bureau of Transportation	U.S. Department of Energy	$100,000	To fund community engagement workshops to educate on TE and gain opinion on the location of pole-mounted chargers
Bonneville Environmental Foundation and Forth	Supplemental Environmental Project, Oregon Department of Environmental Quality	$40,000	To fund two (2) chargers and EV maintenance utilized in Portland for a "carshare" program among community-based organizations

PGE uses the following criteria to evaluate eligibility for grant matching opportunities, which are based on the principles for use of CFP funds established by Commission Order 18-376 in UM 1826:

1. Will the proposed grant project support electrification of Oregon's transportation sector?
2. Will the proposed grant project benefit residential customers?
3. Will the proposed grant project benefit traditionally underserved communities?
4. Is the proposed grant project eligible for external funding?

PGE uses the following program parameters when deploying matching funds:

- If PGE awarded a project matching funds but it does not receive the external funds on which it depends, the awarded CFP funds will revert to the overall DCF funding pool.
- If any matching funds remain uncommitted when annual DCF awards decisions are made, that uncommitted matching fund amount will revert to the overall grant funding pool.

Public Charging Infrastructure

Upgrades to outdated public charging infrastructure continued as part of the Infrastructure and Grant portfolio in 2023. To date, this project focused on updating legacy charging equipment which had been installed and operated by other entities dating back to 2012 (often referred to as the Oregon Electric Byways (OEB). Upgrading and updating these sites proved to be a greater challenge than originally anticipated, as detailed in the 2022 PGE Clean Fuels Program Report.[9]

In 2023, PGE completed upgrades at locations where upgrades were possible. A total of nine public charging ports were installed and are now serving EV drivers. Additional improvements at these sites include:

- Improved charging speed (from 50 kW to up to 125 kW for certain EVs)
- Improved ADA accessibility
- Improved visibility (closer to main thoroughfares)
- Additional payment methods
- Improved overall driver experience through PlugShare score

Remaining allocated-but-unspent funds will continue to support the upgrade of public charging sites operated by PGE to address underperforming charging equipment or other poor charging experience for drivers that rely on public charging. PGE expects this work to continue through 2024.

[9] See https://www.oregon.gov/deq/ghgp/cfp/Pages/utility.aspx

Table 9- Status of PGE CFP-funded Upgrades for Oregon Electric Byways

Electric Byway Site	Location	Charging Capacity	Details
Roth's Fresh Markets	918 N 1st St Silverton, OR 97381	Four ports: two 62.5 kW DCFC (up to 125 kW) and two 7.2 kW Level 2 ports	New chargers online October 2022
IBEW 48 Union Hall	15937 NE Airport Way Portland, OR 97230	One port: 62.5 kW DCFC	New charger online April 2023
Lincoln Center (Shorenstein)	10200 SW Greenburg Rd. Tigard, OR 97223	Four ports: two 62.5 kW DCFC (up to 125 kW) and two 7.2 kW Level 2 ports	New chargers online December 2023

OUTREACH AND EDUCATION

Outreach and Education activities are intended to support customers in the transition to transportation electrification by increasing awareness and building confidence in electric vehicles.

Underserved Community Engagement

In 2023, PGE began a long-term (3-year) Underserved Community Engagement Process to engage members of underserved communities in developing and building upon its Transportation Electrification portfolio. PGE contracted with a minority-owned firm (Thuy Tu Consulting) to lead the work, including recruitment for and implementation of both working groups and focus groups, with the following goals:

- To better understand the perceptions, attitudes, and needs of needs of underserved communities in relation to transportation electrification
- Integrate learnings into the design, implementation, and improvement of TE programs; and
- To build and strengthen relationships between PGE and underserved communities.

The first year of engagement does not align with the calendar year with the outreach work starting in 2023 and continuing through 2024. Through the facilitator, PGE convened a community-centered working group of individuals from the underserved communities demographic outlined in the House Bill 2165 definition.[10] PGE also convened nine unique focus groups of individuals that identify with a specific racial or cultural group. This strategy was recommended for participants' comfort, the necessity of conducting some sessions in Spanish, and because affinity groups often have deeper, more robust discussions. This approach also allows facilitators to identify themes and requests for specific community groups that PGE can use to implement equitable community engagement according to their unique interests and needs. The first of the 13 planned working and focus group sessions took place

[10] See footnote 5

in October 2023. To maximize accessibility for participants across our service area, all sessions were held over video conference through May 2024 (the first year of engagement).

Looking ahead, PGE will incorporate information learned from this process to both inform future engagement strategies and inform and modify its TE program portfolio. The table below provides the dates and subject matter for the meetings held to date.

Table 10- Summary of Working Groups and Focus Groups in Year 1 of Underserved Community Engagement

Session	Topic	Participants
Working Group #1: 10/24/2023	TE and Community Engagement Overview	10
Working Group #2: 11/4/2023	Municipal Pole Charging Program	11
Focus Group #1: 1/4/2024	Overview of TE and Community Transitions to TE	10
Focus Group #2: 1/17/2024	Overview of TE and Community Transitions to TE	12
Focus Group #3: 1/25/2024	Overview of TE and Community Transitions to TE	12
Focus Group #4: 1/31/2024	Overview of TE and Community Transitions to TE	11
Working Group #3: 2/1/2024	Residential Smart Charge Pilot Program, Barriers for renters	8
Focus Group #5: 2/7/2024	Overview of TE and Community Transitions to TE	12
Focus Group #6: 2/15/2024	Overview of TE and Community Transitions to TE	10
Working Group #4: 3/7/2024	Schedule 50 Updates and Clean Fuels Portfolio	9
Focus Group # 7: 3/26/2024	Overview of TE and Community Transitions to TE	9
Focus Group #8: 3/28/2024	Overview of TE and Community Transitions to TE	7
Focus Group #9: 4/2/2024	Overview of TE and Community Transitions to TE	8

This work has already impacted programmatic changes and considerations for future program elements. For example, based on feedback on the Municipal Pole Charging Program, PGE has implemented additional communications strategies to customers to increase awareness of the program. Additionally, in response to hearing from participants

about the Residential Smart Charge Pilot Program, PGE is exploring creating a toolkit for renters and landlords to help navigate EV charging installations at rental properties.

Oregoin' Electric

In 2023, PGE continued to host the redesigned Oregoin' Electric campaign website in partnership with design partner For Good & Co[11]. PGE added analytics on the website including the enablement of tracking of unique visits, "click through" activity, content engagement, referrals, and common keywords. This data will be used to refine the web experience. As the residential EV market expands and engagement increases, elements will be added/adapted to reflect evolving needs and target underserved communities.

Due to limited staffing capacity for the majority of 2023, PGE did not initiate any new campaign activities in 2023. This resulted in only 1,751 total visits to the website throughout the year. PGE added staff in late 2023 to develop a strategy for EV education and outreach for residential customers, including what the future of PGE's role in the campaign will be beyond 2024.

In 2024, PGE will work with Pacific Power and For Good & Co. to update the content on the website to ensure the information remains relevant and reflective of the current EV landscape with content including, but not limited to, EV incentives and rebates included in the Inflation Reduction Act, Oregon's Clean Vehicle Rebate, Utility EV Rebates, and EV benefits. PGE and Pacific Power will also collaborate to inform campaign activities to take place in 2024. Finally, PGE will engage additional external stakeholders, as well as the Oregon Department of Transportation, Oregon Department of Energy, and DEQ to discuss options for EV education and outreach in the market, and what the campaign has provided to-date. Additionally, PGE plans to discuss whether the value of the campaign would benefit from different support models in the future, or if the campaign is not producing in the desired outcomes desired and other options should be explored to support clearer outreach and education for residential customers.

Electric Vehicle Costs and Savings Calculator

In 2022, PGE launched the EV Costs and Savings Calculator on the Company's website, which was continuously updated and promoted in 2023.[12] The calculator uses data from PGE's electricity rates and available state and federal financial incentives to help inform a customer on what owning an EV could look like for their budget and charging accessibility. This interactive tool has a comprehensive, updated inventory of currently available electric vehicles, and their respective available financial incentives. The search page allows users to filter for their vehicle needs, including vehicle type, minimum range, price. After selecting a vehicle, users see vehicle details on one page. Users can change settings based on their vehicle usage, including average miles driven, years of ownership, eligibility for financial incentives, and charging strategy.

---

[11] https://oregoinelectric.com/

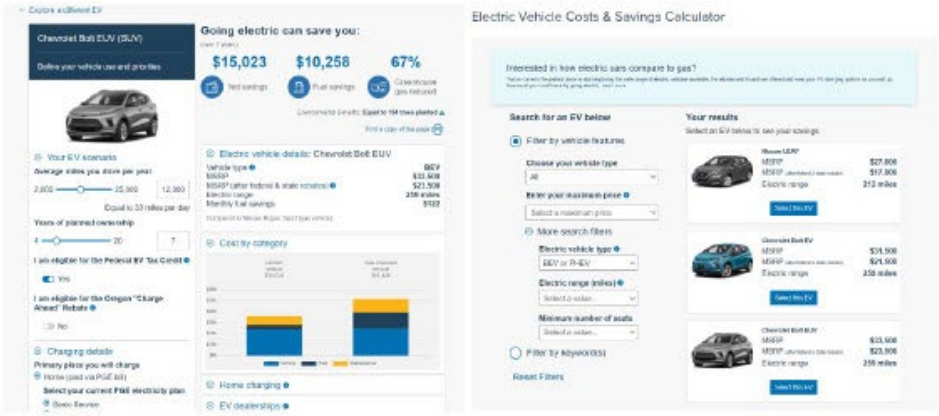
[12] https://portlandgeneral.com/energy-choices/electric-vehicles-charging/ready-to-buy-an-ev/electric-vehicle-costs-and-savings-calculator

After toggling to their usage, users can see estimated net savings, fuel savings, and greenhouse gas emissions reduced.

The tool also includes details such as: electric vehicle specifications, cost by category, home charging options, EV dealerships, and a public charging map. In 2023, there were 13,956 visitors. In surveys taken by site users, 61.9% of users rated the tool 5 out of 5 in ease of use and 70% would recommend the calculator to others.[13] Our evaluations have shown that once people are aware of the savings, incentives, and benefits of electric transportation, they are significantly more likely to consider purchasing an EV.[14] In an ongoing survey of users post calculator use, 55% are more likely to purchase an EV and 45% planned to purchase an EV.

In 2023 PGE engaged our technology partner and a transcreation partner to completely translate the tool into Spanish.[15] This work was completed in early 2024.

Image 4- PGE EV Costs and Savings Calculator



Ride and Drive

In 2023, PGE worked with Electric Car Insider to host five "Ride and Drive" events. PGE leveraged customer feedback therefrom (listed as primary concerns) to update education and outreach materials for 2024 events. We provide a summary of these events below:

[13] Data captured from survey results of 82 users that utilized the EV Costs & Savings Calculator from June-December 2022.
[14] Opinion Dynamics, Evaluation of PGE's Transportation Electrification Pilots, 2020
[15] Transcreation is an intricate form of translating that preserves the original intent, context, emotion and, tone. It differs from translation in that it goes beyond accurate translating words from one language to another to preserve meaning in a culturally specific manner.

Table 10- 2023 Ride and Drive Events

Ride and Drive Event	Attendees	Test drives	Additional Information
June 3, 2023 ***Portland Community College, Sylvania Campus***	334	357	• 13 cars (Ford F-150 Lightning, Rivian R1T, Kia EV6, and Ford Mustang Mach-E were most popular for test drives) • 109 of the 168 attendees asked said they were "very likely" to purchase an EV for their next car, and 43 said they were "probably likely" • 25 attendees already owned an EV • The primary concern of attendees for purchasing or leasing an EV was battery life
June 4, 2023 ***Portland Community College, Sylvania Campus***	292	359	• 14 cars (Ford F-150 Lightning, Rivian R1T, Tesla Model 3, & Ford Mustang Mach-E were most popular for test drives) • 90 of the 149 attendees asked said they were "very likely" to purchase an EV for their next car, and 32 said they were "probably likely" • 16 attendees already owned an EV • The primary concern of attendees for purchasing or leasing an EV is charging
July 29, 2023 ***Bush's Pasture Park, Salem, OR***	210	304	• 12 cars (Kia EV6, Rivian R1T, Ford Mustang Mach-E, and Ford F-150 Lightning were most popular for test drives) • 75 of the 114 attendees asked said they were "very likely" to purchase an EV for their next car, and 24 said they were "probably likely" • 20 attendees already owned an EV • The primary concern of attendees for purchasing or leasing an EV are tax credits/incentives
September 30, 2023 ***Portland Community Colleg,e Sylvania Campus***	195	252	• 10 cars (Kia EV6, Tesla Model 3, and Polestar 2 were most popular for test drives) • 50 of the 69 attendees asked said they were "very likely" to purchase an EV for their next car, and 8 said they were "probably likely" • 26 attendees already owned an EV
October 1, 2023 ***(Portland Community College, Sylvania Campus)***	205	276	• 11 cars (Volkswagon ID.4, Kia EV6, and Polestar 2 were most popular for test drives) • 38 of the 53 attendees asked said they were "very likely" to purchase an EV for their next car, and 10 said they were "probably likely" • 28 attendees already owned an EV • The primary concerns of attendees for purchasing or leasing an EV were battery life and range

In addition to the opportunity to test drive EVs, attendees were able to ask questions of EV owners and PGE subject matter experts about topics such as charging at home or "on-the-go". Attendees will also receive follow-up surveys for 12 months following the event they attended. The survey will track the number of attendees who purchased EVs, were still in process of purchasing an EV, or if they encountered barriers to purchase.

Image 5- 2023 Ride and Drive at Portland Community College Sylvania

EMERGING TECHNOLOGY

Vehicle-to-Grid

In 2023, PGE continued to partner with First Student (a school bus contractor) on the vehicle-to-grid (V2G) demonstration project. The project uses a 60 kW Nuvve DCFC unit installed on property leased by First Student for its Wilsonville-West Linn School District operations. This unit charges a V2G-capable Bluebird Type-C bus with a 155 kWh battery.

In 2022-2023, the project successfully demonstrated the technical ability to discharge power from the bus's battery onto the grid, using manual controls by Nuvve. Originally,

PGE set out to understand whether the V2G charger could be directly controlled by PGE using IEEE 2030.5, a standard communication protocol intended to enable utility management of the end user environment, including demand response, load control, time of day pricing, management of distributed generation, and electric vehicles. This functionality would allow PGE to dispatch the V2G charger and bus in real-time, providing value to PGE operations. However, by the end of 2023, PGE learned that Nuvve would not be capable of supporting the IEEE 2030.5 communication protocol within the expected timeframe of the project.

Therefore, in 2024, PGE developed a scope for Phase 2 of the project using proven methods of control to evaluate the school bus use cases to deliver grid services. As an interim measure, PGE plans to send email notifications to First Student and Nuvve to instruct them to manually dispatch the V2G charger for grid services during scheduled Demand Response events throughout the summer/early fall of 2024. If successful, it will serve as the foundation for future phases of the project to add additional layers of more advanced controls, moving the company closer to a future program that can incorporate electric school buses as a flexible grid resource.

Other Emerging Technology activities

In 2023, PGE began conducting a study of the micromobility market (e.g., electric bikes and scooters) to explore whether and how the company should engage in this space using Clean Fuels funds. Following a December 2023 request for proposals, PGE selected a vendor to implement a study of the micromobility market in early 2024. The results of this study will inform if and how the Company should support customer adoption of micromobility devices beyond the scope of current DCF grant support. The study is now taking place with results expected by the end of 2024.

Conclusion

In 2023, the portfolio program approach spanning Grants and Infrastructure, Education and Outreach, and Emerging Technology continued to provide a consistent structure of program implementation. PGE is pleased to have successfully executed new rounds of the Drive Change Fund and Electric School Bus grants, five ride and drive events, the kickoff of the underserved working groups, micromobility studies and continued V2G research. The company looks forward to continuing its CFP work in collaboration with DEQ, stakeholders, and other utilities to support electric transportation in Oregon.

Appendix A

2023 Drive Change Fund Grant Recipients

Grant recipients as of November 2023

Bird Alliance of Portland (previously Audubon Society of Portland)

Audubon Society of Portland is a nonprofit environmental organization dedicated to wildlife conservancy. Their DCF project includes the purchase of three electric vehicles which will transport Green Leaders participants, conduct facilities maintenance activities, transport injured animals to the Wildlife Care Center, transport plants for the Backyard Habitat Certification Program, and support program staff. They will also install public charging infrastructure at their Cornell campus in NW Portland.

Catholic Community Services Foundation

Catholic Community Services Foundation is a non-profit that is dedicated to serving the community through programs such as affordable housing, mental health clinic, foster care support, and more. Their DCF project includes a public charger and an electric truck that will be used by the Certified Community Health Workers for their Fostering Hope Initiative to create strong families and healthy neighborhoods. The public EV charger will be located at the Bishop Steiner Building in Salem.

City of Salem Public Works Department

The City of Salem's public works department is supporting the City's Climate Action Plan goal of increasing the size of their electrified vehicle fleet. Their DCF project is for the acquisition of a compact electric street sweeper and a transport trailer. This will help clean pedestrian plazas, public spaces, bike lanes and narrow spaces in the city that could not be accessed without this street sweeper.

Columbia Slough Watershed Council

Columbia Slough Watershed Council is a non-profit dedicated to protecting the Columbia Slough and making it more accessible through community engagement, education, and restoration. Their DCF project is for an electric truck, which will haul a canoe trailer to launch sites to provide free paddle experiences for Title I schools, BIPOC-led partner organizations and a wide array of other community members of the watershed. Savings from the switch to an electric truck will be redirected to help ensure CSWC programming remains free to all.

Constructing Hope Pre-Apprenticeship Program

Constructing Hope is a non-profit organization based in Portland, Oregon, that provides pre-apprenticeship training and job placement services to individuals with diverse backgrounds who are interested in pursuing a career in the construction industry. Their DCF project includes two electric passenger vans to transport program participants and two chargers. Constructing Hope trainees will be trained on EV and charger maintenance and skills needed for careers with EVs.

Corbett SD 39

Corbett School District 39 is a public district in PGE's service area serving over 1,000 students. Their DCF project includes installing public charging infrastructure and purchasing

two electric vehicles to begin their district's electrification journey. Savings from the switch to electric vehicles will be diverted to other forms of support for students and families in the community.

Ethiopian and Eritrean Cultural Resource Center

Ethiopian and Eritrean Cultural Resource Center is a non-profit that empowers Ethiopians, Eritreans, and other African refugees and immigrants by providing culturally appropriate services and resources that promote self-sufficiency, integration, and success. Their DCF project includes the purchase of two electric vehicles to support their senior outing activities, youth mentoring and tutoring, and children's activities. Their project will also include outreach to their community about the benefits of electrification and environmental sustainability.

Family Building Blocks

Family Building Blocks is a non-profit certified Relief Nursery committed to keeping children safe and families together. Their DCF project includes a charger and an electric bus to provide vulnerable children and families with transportation to impactful services. This will allow for more children and families to be transported to vital programs.

Friends of Noise

Friends of Noise is a nonprofit that supports culturally specific youth music enrichment with programming services that are directed toward communities that have been historically underserved. Their DCF project includes a charger and an electric vehicle to increase services and offer more programming in new neighborhoods and serve more youth.

Friends of Trees

Friends of Trees is a nonprofit with a mission to inspire community stewardship of our urban forest by bringing people together to plant and care for urban trees and natural areas. Health impacts related to rising temperatures are worsening, disproportionately impacting lower-income communities. Friends of Trees increases access to shade, which lowers temperatures, as well as provides cleaner air and other benefits. Their DCF project will purchase chargers and an electric vehicle to continue their services of planting and watering trees with community volunteers.

Growing Gardens

Growing Gardens is a nonprofit that supports low income and BIPOC individuals, families, and communities in neighborhoods with food insecurity, lack of access to fresh foods, and lack of access to culturally preferred foods. Their DCF project includes chargers and three electric vehicles to transport staff and materials to continue their horticultural education, backyard garden program and other workforce development surrounding horticulture.

Habitat for Humanity Portland Region

Habitat for Humanity is a nonprofit organization that helps families build strength, stability, and independence through affordable homeownership. Their DCF project includes four chargers and five electric vehicles (including four electric forklifts), to continue their services of transporting Habitat families and staff, as well as improving the air quality in their warehouse. The public charger will provide much needed charging infrastructure in a dense, low-income residential area.

Latino Network

Latino Network is a nonprofit organization that provides culturally-specific education that lifts their youth and families to reach their full potential through programs and services. Their DCF project includes an electric vehicle and chargers at their new La Plaza Esperanza community center and preschool in the Rockwood neighborhood. The electric vehicle will support the onsite preschool students, provide educational services, and other culturally-specific wrap-around services for their community.

NW Pilot Project

Northwest Pilot Project provides services to low-income, disabled, and disenfranchised seniors in Multnomah County. Their DCF project includes an electric vehicle to transport clients into housing, deliver supplies and furniture, and transport staff to check in-person visits. NW Pilot Project staff and clients want to provide heathy housing and transportation, considering that low-income citizens are vulnerable to the negative effects of climate change.

Oregon Health & Science University

Oregon Health and Science University's Doernbecher Children's Hospital offers the region's most comprehensive and advanced pediatric health care services to meet the needs of children from before they are born through transition to adult care. Their DCF project includes three electric vehicles and charging stations that will be used to transport staff, patients, and families for their Doernbecher Outreach and Novel Interventions in Children's Healthcare (NICH) programs. Their grant also includes the purchase of a mini-EV for their pediatric patients within the hospital to bring joy and share information about electric transportation.

SOLVE

SOLVE is a non-profit organization that restores and preserves Oregon's environment through litter cleanups. Their DCF project is the acquisition of a charger and electric vehicle. The vehicle will be used to transport debris, larger items, and tools for cleanup events, as well as expand the impact of this organization across the state. This electric vehicle will help serve unhoused and low-income areas, waterways, greenspaces, and neighborhoods in a more sustainable way.

The Community Services Network

The Community Services Network is a non-profit that facilitates a network of nonprofits, community members, government agencies, and companies that provide wraparound services to communities. Their DCF project includes electric vehicle education, an electric vehicle, and chargers. This project will help the organization's growing need for transporting necessities such as clothing, equipment, donations, and materials for educational fairs in underserved communities.

The Street Trust

The Street Trust is a non-profit that advocates for multimodal transportation centered around safety, accessibility, equity, and climate justice. Their DCF project will provide 75 electric bicycles in a ride-to-own program in underserved communities. This program will enable participants to travel from their home to work, school, and other essential daily

destinations. This project will serve 75 low-income community members, with 75% of the electric bicycles are committed to members of the BIPOC community.

United Way of Mid-Willamette Valley

United Way of Mid-Willamette Valley is a non-profit that convenes and mobilizes local businesses, community leaders, public officials, and community members to provide opportunities for success. Their DCF project is an EV Switch Vehicle and Build Kit for the Career Technical Education Center (CTEC), a technical career high school program for high school juniors and seniors specializing in Autobody Paint and Repair services. This project will empower students in the Salem-Keizer School District to pursue EV car maintenance and repair training in high school while also giving them the opportunity to obtain a tech job at an autobody shop after graduation. This also helps small automotive shops in the area that can't afford to send their staff out of state for expensive EV training to service these vehicles.

Virginia Garcia Memorial Foundation

Virginia Garcia Memorial Foundation is a non-profit that provides comprehensive and culturally appropriate primary health care to the communities of Washington and Yamhill counties, with a special emphasis on migrant and seasonal farmworkers and others with barriers to receiving health care. Their DCF project is for the acquisition of an electric vehicle to deliver prescriptions to patients who are unable to visit the Cornelius Wellness Clinic pharmacy due to long working hours, lack of transportation, mobility issues, etc. This project will allow the clinic staff to provide critical prescriptions, while promoting clean energy and reducing pollution for patients with asthma and other chronic health issues.

Appendix B

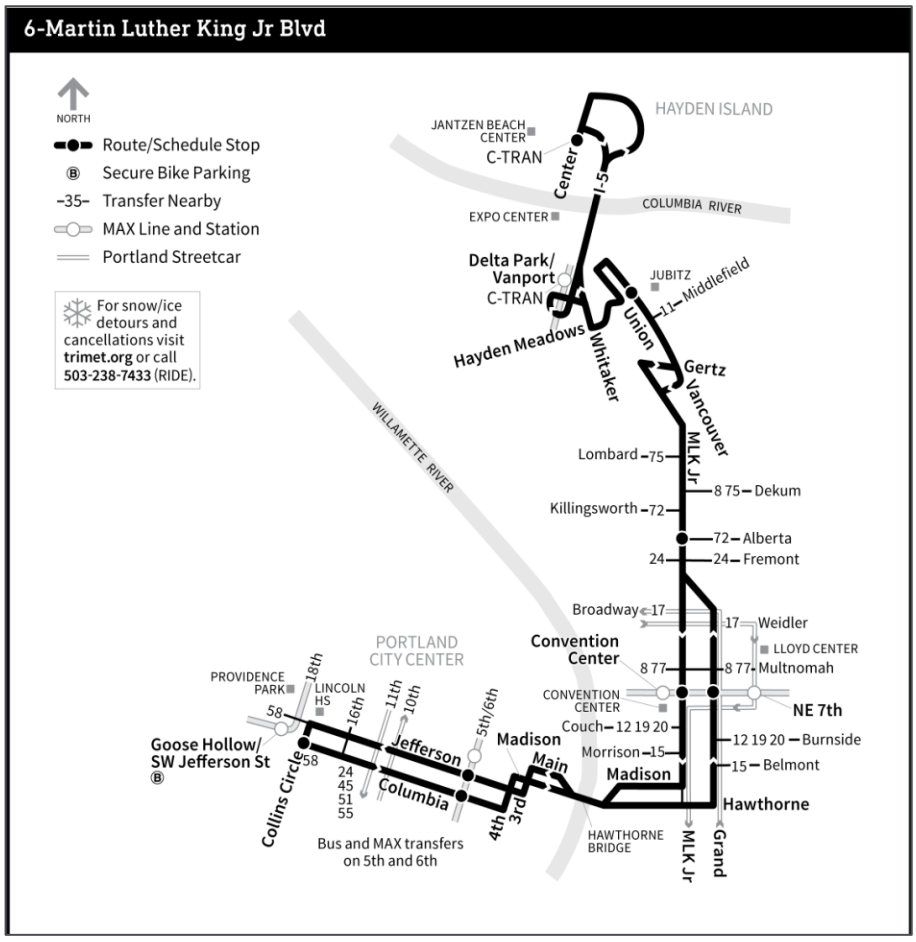
See PDF Attachment B; Drive Change Evaluation

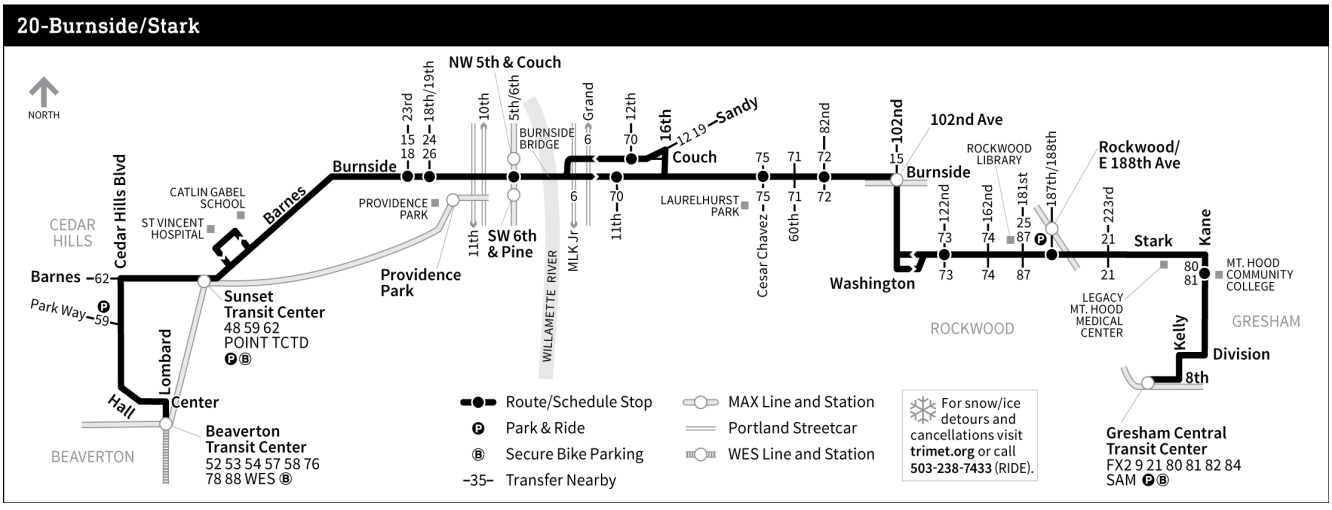
Appendix C

See PDF Attachment C; Electric School Bus Report

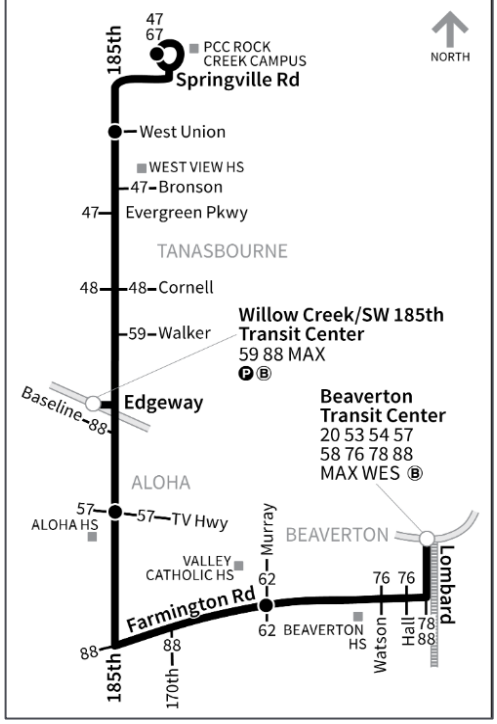
Appendix C: Transit Agency Route Maps Served By Electric Buses

Electric buses supported by the TriMet chargers included in UM1938 pilots serve six different routes in the PGE service area. All six routes benefit underserved communities: Line 6, 20, 52, 54, 57, 62.

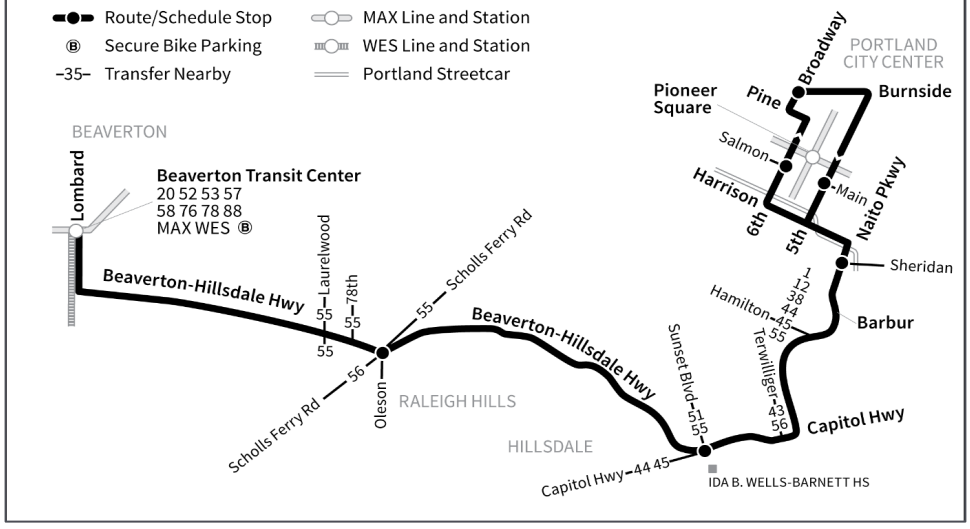




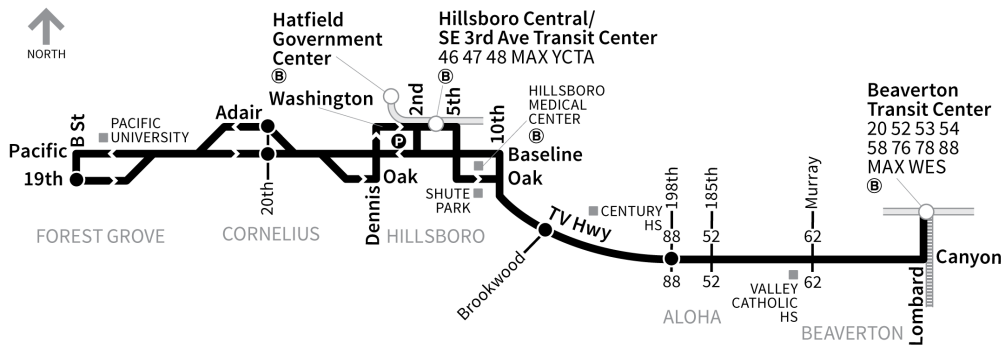
52-Farmington/185th



54-Beaverton-Hillsdale Hwy



57-TV Hwy/Forest Grove



62-Murray Blvd